SCIENCE

VOL. 103 *Friday, January 11, 1946* NO. 2663

In This Issue

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John G. Jenkins

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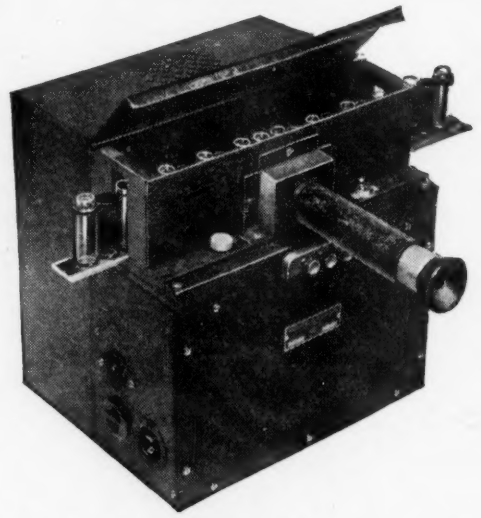

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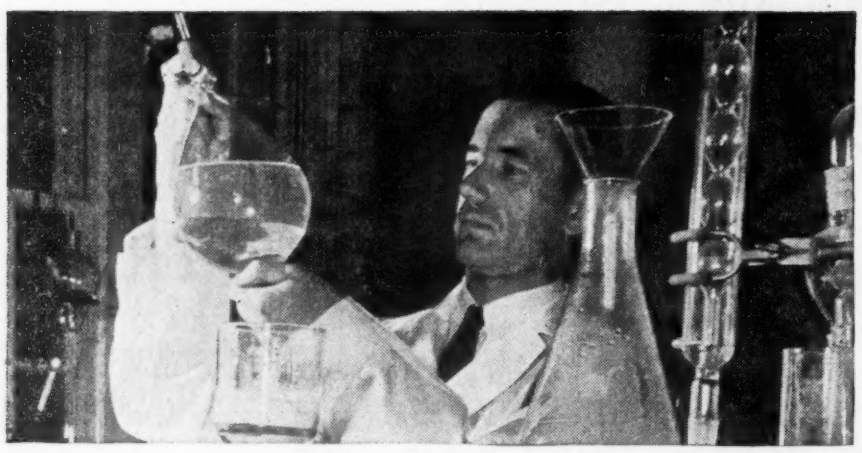

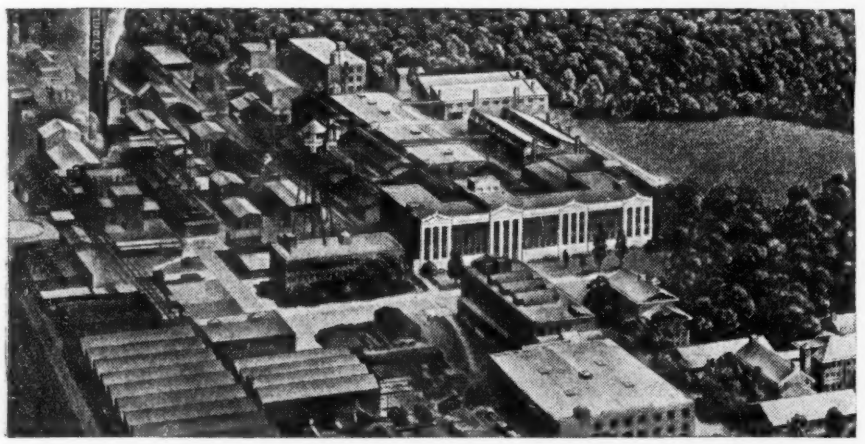

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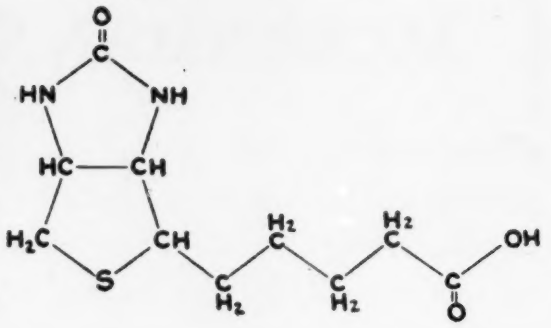

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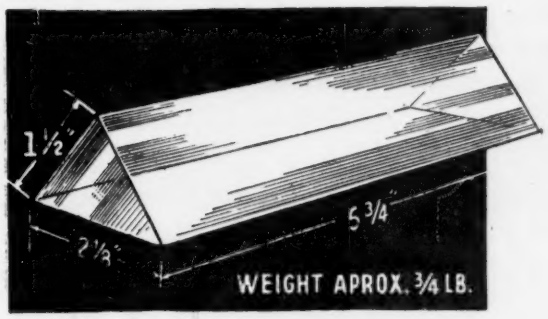

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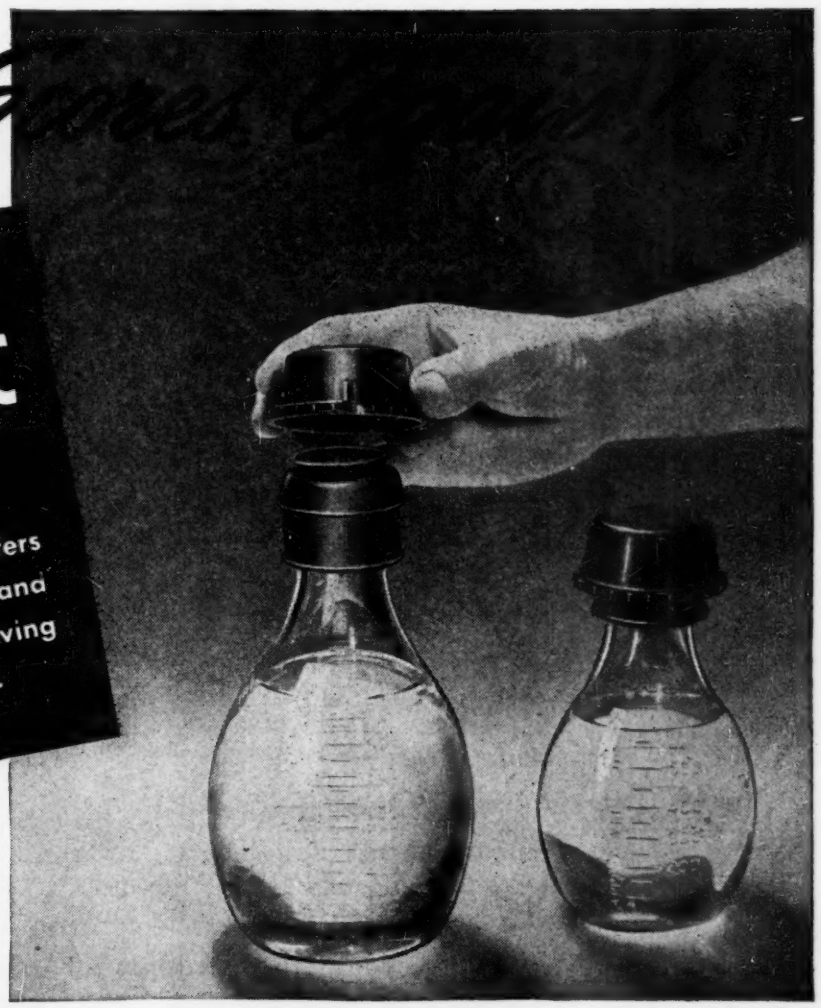

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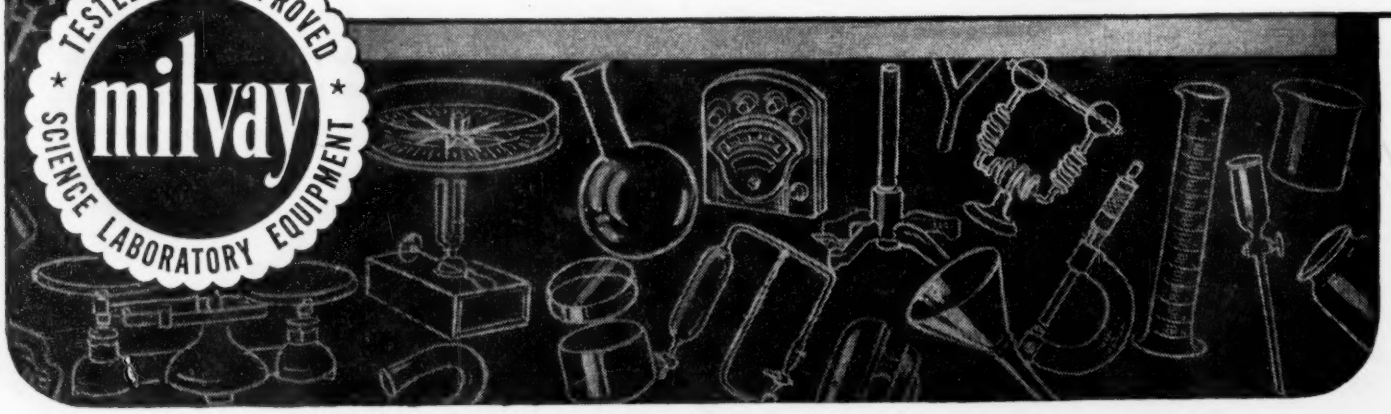

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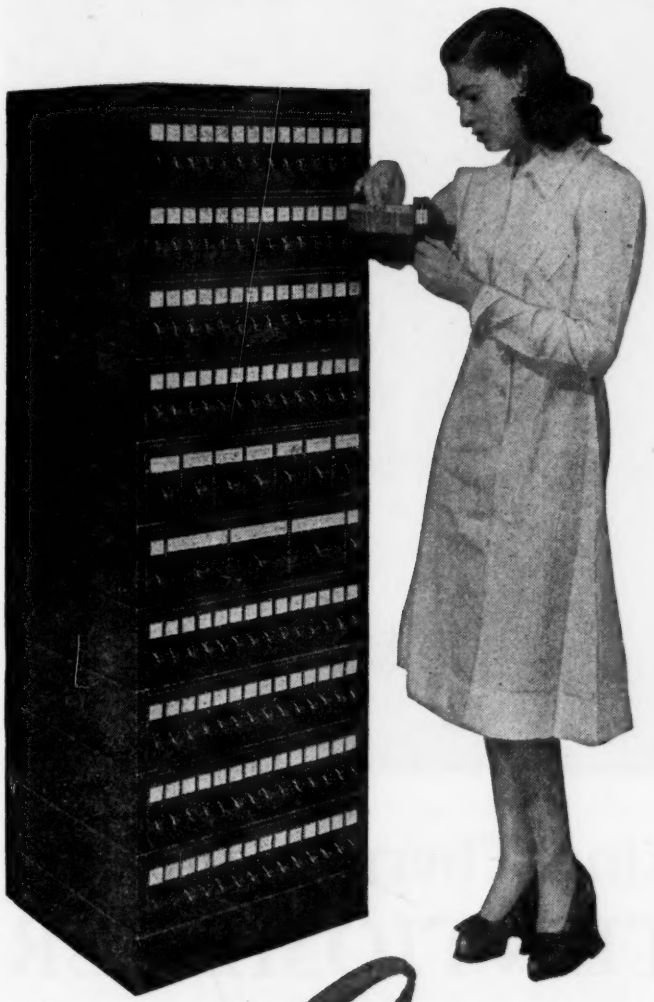

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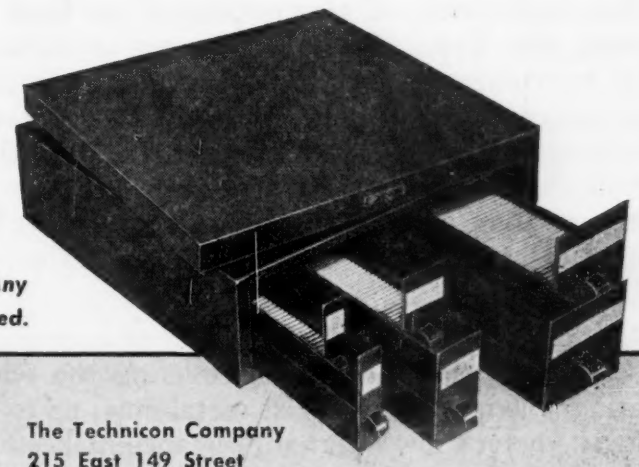

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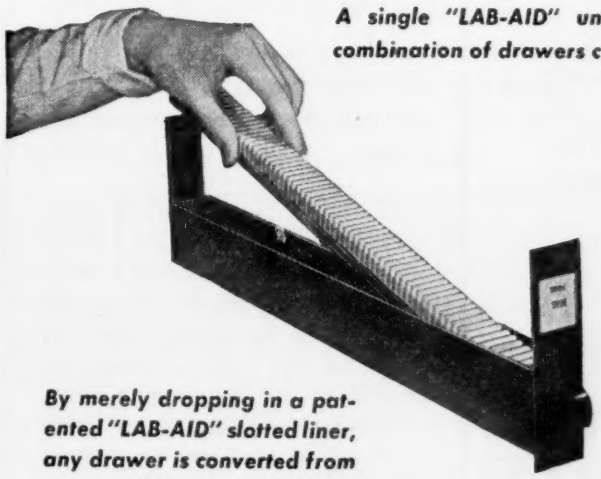

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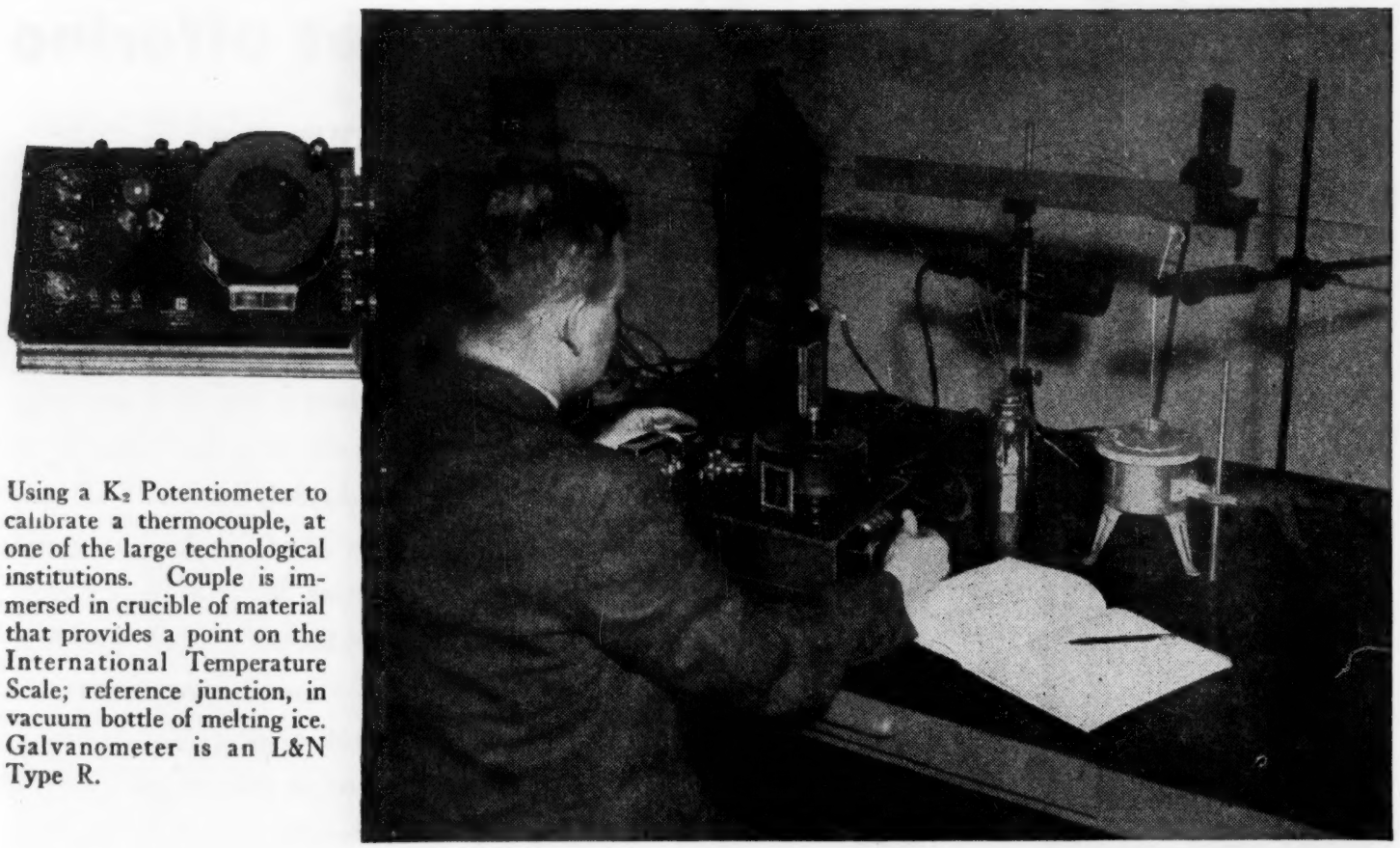

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SCIENCE

Vol. 103, No. 2663 Friday, January 11, 1946

New Opportunities and New Responsibilities for the Psychologist[1]

John G. Jenkins, Captain, H(S), USNR
Navy Department, Washington, D. C.

WE ARE NOW ENTERING the after-dinner phase of psychology in World War II. The hunger-pangs that disturbed us a short time back are now quieted to the point of satiation. The cortical cells are experiencing that pleasantly-toned anoxemia that takes place as digestion exerts its priority over cerebration in the employment of vital bodily fluids. It is time to push back the chairs, to light up cigars, and to reflect on how well we have done by our country, by our profession, and by ourselves in the war years just past.

The reflection becomes all the more pleasing as we are made aware of the contrast between 1941–1942 and 1945. It may not be too much to say that most of us here at this meeting came into the military services through the servants' entrance. We were brought in, in an era of gloom and defeat, under the conviction that things were so bad that any available magic should be tried, even psychology. We have worked four years, more or less. Now we are going out the big front door, labeled as military specialists, while the band plays "Hail to the Psyche." Victory has replaced defeat; concrete realization of what psychologists can do has replaced a vague hope that they might possibly do something; and a warm and cordial acceptance has replaced a suspicious and grudging admission to the military work-place.

It is indeed a time to pass the brandy—at least figuratively. It is a time to make preparation for the moment when we shall stand in front of the assembled regiment or ship's company and hear the general or the admiral recite aloud our virtues. It is a time to lean back in our seats and harmonize on a few stirring verses of "The Cortex, the Cortex, Forever." And, above all, it is a time to look forward to returning to our several campuses as recognized experts.

Yet even as we relish the finer moments of the glowing after-dinner mood, we are uneasily aware that we shall never return to the campuses we left, at least as we knew them. The good, well-rounded world of 1928 and of 1938 is gone forever. It would ultimately have been destroyed, in any event, by the social currents of which the war was only an epiphenomenal symptom. It was already in its last days when we marched off in self-conscious awareness of our new uniforms, four years ago. But it was not allowed to die a natural death. Its final destruction came about through an explosion. An American airplane dropped a bomb no heavier than a week-end suitcase. A small city was destroyed; and with it was destroyed much of the basic framework of the social world we inhabited before the war.

So we sit here uneasily, you and I, pondering the fact that the whole parameter of personal success bulks very small indeed in a world which is earnestly trying to find out whether the human race must necessarily destroy itself. Official kudos, medals, the offer of a better job—all these things seem curiously unimportant as we try to revise our scheme of things to fit a world in which a city may vanish in the flash of an eye and a whole nation may perish between sunrise and sunset.

Instead of the long-anticipated era of congratulation and self-congratulation, then, we find ourselves in a period of searching self-examination. Instead of counting our medals, we are engaged in taking a stock of the primitive tools with which we must hope to master an unending task of incredible difficulty in the years ahead. I should be running vainly counter to the most significant intellectual trend of my professional lifetime, then, if I were to devote this hour to the more or less conventional and expected review of the fine things we have done. Instead, the occasion

[1] From an address delivered at the Conference on Military Contributions to Methodology in Applied Psychology, held under the auspices of the Military Division of the American Psychological Association at the University of Maryland, 27–28 November 1945. The full text of the address and of the papers presented at the Conference will appear in a volume to be published by the University of Maryland.

requires that I shall spend the time trying to assay what we have and what we may hope to do with it. The humility that anyone must necessarily feel when confronted with such a task is not decreased by the realization that editorial writers are now inviting the social scientist to enter a game of chance in which the stakes are the survival of the human race.

What I have to say to you about the new opportunities and new responsibilities of the psychologist will be understandable and acceptable in proportion as you are willing to agree to my thesis that psychology is now entering a third phase of its development. The first phase, extending roughly from its founding down to about the 1920's, was the phase of *local* loyalty. The second phase, from the 1920's to the 1940's, has been the phase of broadened *professional* loyalty. The third phase which we are now entering must, of necessity, be the stage of *social* loyalty and *social* responsibility.

Please do not bother to object that phases in the genesis of any science are not as clear cut as that. I know that as well as you do. It is quite true that there are many individuals who fall outside the pattern of these phases. You may be sure, then, that I am not trying to describe any series of universal and all-inclusive temporal groupings. I am trying only to suggest a modal pattern, attempting to locate the movement of the majority of the profession, and content to allow the exceptions to fall where they may.

In that light, let us return to the thesis of the stages. As psychology developed through its first half-century of existence, local loyalties tended to run high. One belonged to a department which possessed the Only True Path; the rest of the field was tenanted by infidels who followed false gods. Wundt, when asked about Stumpf, whose laboratory was only a few miles away, was merely reflecting the spirit of the times when he said that he had never heard of Stumpf. Titchener was wont to dismiss the efforts of some of his extramural colleagues with the statement: "That may be all right, but it isn't psychology." There were not only schools of psychology but local brands of schools. Facts were few; logical constructs were numerous. The whole setting lent itself nicely to fine differences between *mine* and *thine*. The speaker, coming into psychology in the early 1920's, found himself in the midst of this. It was a good lusty era in which you joined up with a psychological team, ordinarily on the basis of a geographical accident, and thenceforth fought lustily to show that your team was right.

Phase Two was a natural evolution from Phase One, as facts accumulated and methods became less particularized. Just about the time that someone thought of getting out a volume on the 'schools of psychology' the schools themselves began to lose their identity and their sharp competitiveness. As early as 1926, one outstanding behaviorist confessed to the writer that a seminar which he had convened to justify behaviorism had convinced him that he was himself not a behaviorist.

Set the dates where you will, the trend remains unmistakable. There is no better proof than to ask you here to look around and determine what 'school' your immediate neighbors belong to. The chances are excellent that you will fail completely at this task. It may not be too much to say that each 'school' has had certain protests to make. It has made these protests, which were then absorbed in the main body of a research psychology, after which the main body moved along. There are few of us today who cannot acknowledge personal debts to Structuralism, Functionalism, Behaviorism, *Gestalttheorie,* and the teachings of the psychoanalysts. Beyond these broad divisions, we have also been stimulated in considerable amount, and with considerable profit, by contact with topology, with operationism, and with emergent evolution. We have gained from our contacts with such varied approaches as nondirective interviewing, projective testing, factor analysis, and the studies of expressive movement—to name only a few influences. But increasingly our identification has been with research psychology as a whole, rather than with any special movement or any particular set of techniques.

World War II has afforded the best demonstration that Phase Two has been a reality. The man from Nebraska has worked alongside the man from Palo Alto without the need of an interpreter. The young officer who had his statistics under Thurstone has found much common meeting ground with the lad who had studied under Kelly. There has been much stimulation in this business of working together and precious little intramural strife. Today, as never before, research psychology is a discipline which is much bigger than local loyalties and much wider-reaching than the confines of any school. And, unless you yearn for the complacent security of the Old School Tie, you will say that this is good.

It is good, I agree; but it is not enough. We must now be ready to enter a third natural phase of development. In Phase One, we demanded that a man belong to the Right School before we would break bread with him. In Phase Two, we ceased to ask him what school he had attended; we asked chiefly that his work should be sound, that he should check his critical ratio, and that his conclusion should not outrun his data. In Phase Three, the satisfaction of the one-per cent level of statistical confidence will not in itself be enough; we shall now have to ask not merely whether a result has *statistical* significance, but

also whether it has *social* significance. When that becomes commonplace, we shall have entered Phase Three.

You will readily understand, I am sure, that this is not a matter of choice. If we do not ourselves freely adopt the idea of checking the social significance of our findings, it will be thrust upon us from outside the profession.

Well, you may say, we do all that already. We psychologists have our Society for the Psychological Study of Social Issues. We teach courses in social psychology. In our local communities we have worked with social problems and gone afield to meet social issues. So we are already in Phase Three.

If you can make such an answer, you show that you have failed completely to grasp how broad are the implications of membership in Phase Three. Social responsibility does, of course, include a willingness to meet and deal with social issues. But it goes far beyond that. Social responsibility for the research psychologist touches his professional life at every point. It determines what problems he shall select for his attack. It determines, to a considerable extent, what shall be accepted as methodologically respectable methods of attack upon these problems. It also determines, to some extent, how he shall interpret his findings and how and where he shall publish his interpretation.

It will be quite apparent to you that no one paper can hope to explore the varied implications of social responsibility for the social science investigator. I therefore propose to limit my discussion to what may be, for some of you, the least obvious aspect of the implications. That will mean that I shall attempt to indicate how—as I see it—a continuing sense of social responsibility affects and influences the very problems upon which he chooses to conduct his researches.

Let me begin by stating a postulate which attempts to describe the motivation of the choice of problems for research. Stated in its baldest terms, this runs about as follows:

> As long as choice of problems is primarily determined by a feeling of *professional* responsibility, the investigator is most likely to select problems which hold promise of early returns, obtained by conventional methods. In other words, professional responsibility seeks out problems in terms of their promise of methodological neatness.
>
> A sense of lasting *social* responsibility, on the other hand, demands that trained investigators turn their attention to the most pressing social problems. Neatness of result—and its accompanying professional acclaim—must often be sacrificed in order to attack problems which, although not promising early or definitive returns, are of immediate importance to social stability.

Some of you may say that that is an indictment. It implies that applied psychology has dodged some of its social responsibilities. But let us review some of the evidence.

Psychological Tests

Suppose we begin by looking first at what is perhaps the psychologists' best-known working tool—the psychological test. Psychological testing saw its birth during World War I and reached its greatest peak of usefulness, up to this time, in World War II. Papers presented during this Conference have shown what widespread use was made of psychological tests during the period of the war. Tests were used to select fighting men, to classify them for their best employment, and to determine their best possible usefulness under fire. Certainly not fewer than ten million men in this country alone submitted to some sort of screening by psychological tests; and certainly the tests themselves operated overall at a level of predictive efficiency not hitherto achieved.

This is an accomplishment to which we psychologists may point with great pride. It is possibly the most important single contribution that applied psychology made to the very important and practical business of winning the war. Yet, while it is good, it is also revealing.

Consider the fact that our best-developed tests are probably tests of intelligence. We have made great advances, as a profession, over the intelligence tests used in World War I. A wealth of serious debate during the 1920's set the stage for the factor analysis surveys of the 1930's. We have as a result been able to learn much about the composition of intelligence. The typical intelligence test of the 1940's, partly as a result of such surveys, is a rather well-advanced tool. It contains a large percentage of discriminant items and affords a usefully broad range of scores, and it is characteristically high in reliability. As a result of correlational studies, we know a good deal about the relationship between intelligence test scores and progress in education, in industry, and in the military hierarchy.

Now all of this is good; but it is also significant for my thesis, for intelligence is perhaps the best-behaved, the least troublesome, and possibly the least modifiable of all our behavioral characteristics. It does not represent much of a social problem. The man in the street, without help from the psychologist, has pretty well figured out what to do about differing levels of intelligence. In the main the work of the psychologist has served only to confirm and justify the rule-of-thumb procedures which have been handed down as a part of our common-sense social inheritance. The work on intelligence testing has been well worth doing; but it has been accomplished while other and much more pressing social problems were thrust aside.

Personality Tests

Let us consider some of the less well-behaved aspects of human behavior. Take that vague and undefined term 'personality.' In our everyday life it bulks as

considerably more of a problem and as considerably more subject to modification and change than intelligence. Our ready-made social fabric is much less certain in telling us which individuals are wide of the average in their emotional and social adjustments. Indeed, a recently published best seller suggests that hundreds of thousands of people a year are taking their suspected personality troubles to countless varieties of quacks and charlatans. Clearly the situation demands that the psychologist, as rapidly as possible, shall develop tests which will accurately reflect how any given individual deviates from the social or emotional norm; and it demands that the psychologist shall indicate ways of reducing undesirably large deviations, if, indeed, modification is possible.

The problem has great social significance. What does organized psychology have to offer, in 1945, toward its solution? The plain answer is, very little indeed. Where the intelligence test of 1945 is a recent product, based on hundreds of careful researches, I am informed that the most widely used "personality" test at this time is one published in the early 1930's and based on work completed in the 1920's. Researches on this test have been few; and their outcome has been almost entirely negative. Attempts to validate it against available criteria have, so far as I am able to learn, yielded nothing to encourage us to believe that it gets at clinically identifiable aspects of behavior. Furthermore, such studies as have been made of the traits it purports to measure suggest that these alleged traits are in themselves so unstable as to limit the test to a uselessly low level of reliability.

One may well ask about some of the other attempts to get at personality, such as Murray's work, Shipley's Inventory, the Minnesota Multiphasic, and, above all, the work in projective tests. The answer is simply this: Granted that certain men are exploring promising angles, the vast bulk of American psychology has not advanced in its thinking about personality tests since the 1920's. If we are concerned with large-scale movements in the field, we can feel no elation over the explorations of the few. We shall not have met the social challenge of the need for personality-measuring instruments until psychologists in considerable numbers have sacrificed the professional gains of working neatly on further definitions of intelligence to work upon the unsolved, and possibly unsolvable, problems of defining the place of a given individual in the area of social and emotional adjustment.

Public Opinion Polls

The example just cited is by no means an isolated one. As you leaf through any year's issue of the *Psychological Abstracts,* you will be struck by the inevitability with which our profession in the main has chosen the neat, rather than the socially significant, in finding problems worthy of its researches. We have, for example, devoted much time and thought to improving the predictive efficiency of our public opinion polls; yet we have pretty consistently dodged the issue of trying to determine what effect the polls themselves may have upon the voters. Alarmed politicians may insist that the polls, by inducing a desire to climb on the band wagon, have seriously altered the political picture. In the main, our researchers have preferred to wave this charge off and to work on the improvement of their polling methods. And, as you review the situation, you may again be struck by the fact that the improvement of predictive efficiency is a neat, quantitatively expressible problem, while the measurement of band-wagon effects is unorthodox, complicated, and difficult of quantitative expression.

Education

In our public schools you will find many parallel illustrations. Researches of the past fifty years have brought out a wealth of information as to how to improve teaching. We can now, with some assurance, tell the teacher how to get better attention, how to assure lasting memory, how to motivate his students to work, and, in general, how to induce them to perform well on scientifically improved final examinations. These are all real gains; but they dodge the basic issue of what changes, if any, are produced in our students by their education. We cannot say, with even the slightest degree of scientific assurance, what any given course, or any given curriculum, contributes to the making of a wise and stable citizen. We are totally unable to say which courses make critically important contributions and which make negligible or even negative, contributions. In other words, we who set high standards of validity for our predictive tests are totally without information as to the validity of any of the elements which make up our modern curricula.

Alcohol

The exhibit can be expanded endlessly, but here I shall include only a final example. We may begin by pointing out that we know a good deal about the primary effects of alcohol upon human behavior. This is scientifically interesting, and it is useful. Yet the social problem here is pretty well solved by our folkways. Society does not admit the judge to the bench or the teacher to the rostrum while in a primary stage of intoxication. It penalizes heavily the drunken driver and the drunken aircraft pilot. In general, society at large recognizes that a man in a primary state of intoxication is incapable of wise and well-coordinated behavior. Our researches, it appears, do little more than confirm and quantify what the man

in the street has known since the days of the Old Testament.

Turn from this to the state that *follows* intoxication and you have a different story. Society appears to be puzzled about what to do with the man who has a hangover. He is admitted, possibly with an admiring leer, to the bench or the schoolroom. He sits at the council table in the industrial establishment. He is permitted to drive his car or fly his plane. Yet through all this runs a thread of social uneasiness. We learn that certain commercial airlines take steps to prevent drinking within twenty-four hours of a scheduled flight. We hear of business executives who defer all decisions when they are admittedly recovering from overindulgence. The attitude of society, in other words, appears to be equivocal; it looks to science and technology to supply valid estimates of how, and how badly, a man's resources are reduced by the presence of a hangover.

Here is a socially significant problem, amusing though it may seem at first sight. How much have the research disciplines to say about it? Although there are literally thousands of articles reporting investigations into the primary effects of alcohol, there were, the last time I checked, exactly *three* research articles on the nature of the hangover. The fact that none of these three met the ordinary standards of sound research is irrelevant. The basic fact is that, on the equivocal problem of the hangover, research is silent; it has nothing to offer society. A major reason, I believe, is simply this: The study of the primary effects of drinking is neat; it promises early returns, based upon adequate use of controls, and leading to nicely quantitative results. The hangover is a messy topic. Controls are uncertain, and the outcome is likely to be something less than clear cut. Social scientists have turned, almost without exception, to the study of intoxication itself and have shied away from the socially important, but methodologically unpromising, study of the aftereffects.

If you doubt the fundamental thesis as given here, you may turn to any of the annual indices and make your own tabulation. It can scarcely fail to convince you that the social significance of a problem has been a determinant only for the few; the many have persistently devoted their research efforts to the methodologically neat, with a bland indifference as to whether the outcome met any social need or not.

You may be ready to object that, by raising this issue, I am striking at the very basis of sound research. You may object that the job of the investigator is to investigate and that, in science, no problem is any more important than any other. You may urge that investigating the effects of a one-degree rise of temperature on the maze-solving habits of the tapeworm is, by definition, just as important as the study of why men fight. If you do, it will be a familiar argument, for the speaker was raised on the concept of a science which mercilessly and objectively sought out its facts and let the chips—and the human race—fall wherever they might. He was raised on the stereotype of a scientist who had no social responsibility and who was motivated solely and entirely by the desire to discover the generalizations under which future occurrences might be predicted.

It is a picture not without some considerable appeal. It may have been quite adequate to the world of yesterday; but it has now lost its adequacy. That is not to say that the social scientist should not work upon problems which have no immediate and obvious application. He should and he will. Indeed, it is important that our research people should be left relatively free to work on such problems as their own consciences may direct, for only thus can science and technology progress.

Applied *vs.* Pure Research

At the same time, let us free our thinking from one error. There has long been in existence a vague belief that something called 'pure science' developed basic methods which it then handed over to 'applied science' for use in practical contexts. I am told that this is at best a partial truth in other sciences. I know that it is rarely true in psychology. A careful review of the last twenty years in applied psychology will show that many, if not most, of the methodological advances in applied psychology were made by men working directly in some practical context. This being the case, researchers can afford to devote much of their time to working on practical problems without any fear that the development of new and basic methodology will thereby cease.

It is encouraging to note that psychology at large has already had four valuable years of practice in working at problems of social significance. It is encouraging to note that this work has been sound enough to evoke the support of hard-headed military realists. One aspect of this situation is worthy of particular note. It is worthy of particular attention that men who were brought in to work upon very specific and highly localized technical problems found themselves increasingly assigned to tasks of greater complexity and greater significance. Men originally assigned to the improvement of selective tests gradually earned the right to work with whole systems of classification for combat assignments. In many cases work with relatively simple criteria based on outcome of training led over into the much more complicated, and more significant, evaluation of actual performance under fire. Psychologists originally assigned to improve the mechanics of day-to-day examinations finally

were given a free hand in revising whole programs of training and, indeed, of redefining the whole purpose of the training program. As the detailed history of this war is published, the thoughtful reader will see that here, as never before, psychologists have progressed from an original attack on the neat and simple to a later and more prolonged concern with the militarily important and methodologically complex. It is the speaker's conviction that this will ultimately be regarded by our profession as the most significant development of the war for the future of psychology.

It is of the greatest importance that the lessons of the war shall not be lost. It is of the greatest importance that attitudes and techniques which proved to have real practical significance in attacking the primarily destructive social problems of the war shall be carried over for attacks on the primarily constructive social problems of peacetime. Yet this will be accomplished only if psychologists in general recognize how they have achieved their present military status and if they recognize why they must transfer their efforts and their zeal to the attack upon common social problems.

To this end, careful note must be made of one significant motivating influence of the wartime period. In the main, psychologists were not permitted to remain in their laboratories, or to work upon military problems in the comfortable isolation of their own campuses. Characteristically, they were transported bodily to the military establishment and compelled to live in day-to-day contact with military folk and military problems. As they sweated out tours of duty, they began to work upon certain problems—in a very large number of cases—simply because the problems forced themselves on their attention, day after day. Their problems, if you please, arose from the persistent demands of the environment rather than from the pressure of some systematic conviction or professional nicety. You will readily understand that the voice of the military environment became audible because the trained investigators were there in the military environment itself. If they had remained in their laboratories and in their studies, the voice of the military environment would have been, at best, muffled and not improbably distorted beyond recognition.

You have heard my thesis. I advance it with the greatest humility, not as a revelation of some novel truth but as an effort to formulate what everyone here must surely realize. You may well ask why I bother to state the thesis at such length, if everyone recognizes its existence. It is advanced as the formulation of one hypothesis which may serve to stimulate some proportion of this group to think beyond the hypothesis itself toward the solution of a basic problem. If such thinking should serve to negate the hypothesis I have advanced, well and good. The fate of the hypothesis is of infinitely less importance than that clear thinking should be done by those who are charged with socially significant researches. The war has given the profession of psychology its greatest forward impetus toward the achievement of a place of importance at those council tables where the future of mankind may well be decided. It is by the thinking of such folk as you who are assembled here that the effectiveness of these later councils will be determined. May you think well!

Scanning Science—

At the August meeting of the German Society of Anthropology, at Cassel, the opening address was by Dr. Waldeyer, of Berlin, on "the somatic differences of the two sexes." Its aim was particularly to bring out the contrasts between woman and man, with the purpose of applying the results to the education and "sphere" of woman. He argued that since a wide collation of measurements and statistics proves that she has a smaller brain, has less physical strength, preserves more traits of infancy and childhood in adult life, and has practically in all times and places held a position inferior to the man, that in our schemes of social improvement these undeniable facts should be respected. The efforts of social democrats and society leaders to establish entire equality between the two sexes and to throw open to woman all the avenues of activity enjoyed by man, he intimates, are mistaken and will prove failures; and quotes with approval the opinion of Bartels, who maintains that the education, physical and mental, of woman, however high it may be, should be always aimed to fit her for the duties of the family circle only. This conclusion will not be in the least acceptable to the "advanced" women of the day, nor to those sociologists who see in woman's present condition, not the model of the future, but a survival from a barbaric past.

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S. 1720

THE NEW SCIENCE BILL which was introduced into the Senate on 21 December 1945 was briefly analyzed in last week's issue (*Science*, 1946, **103**, 10–11). Using S. 1297 (the original Kilgore Bill) as little more than a point of departure, S. 1720 evolved from the October hearings sponsored by Senators Magnuson, Kilgore, and Fulbright. In the belief that the importance of the legislation requires scientists to be familiar with the details of the bill, the full text follows:

In the Senate of the United States

79th CONGRESS, 1st Session, 21 December 1945

Mr. Kilgore (for himself, Mr. Johnson of Colorado, Mr. Pepper, Mr. Fulbright, and Mr. Saltonstall) introduced the following bill, which was read twice and referred to the Committee on Military Affairs:

A bill to promote the progress of science and the useful arts, to secure the national defense, to advance the national health and welfare, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Science Foundation Act of 1945."

Declaration of Policy

SEC. 2. The Congress hereby finds that a full development and application of the Nation's scientific and technical resources is essential for the national defense, national prosperity, and the national health and welfare. The Congress declares it to be the purpose of this Act among other things to provide support for scientific research and scientific development, to enable young men and women of ability to receive scientific training, to promote the conservation and use of the natural resources of the Nation, to correlate the scientific research and development programs of the several Government agencies, to achieve a full dissemination of scientific information to the public, and to foster the interchange of scientific information in this country and abroad. The Congress further finds it essential for these purposes to create a central scientific agency within the Federal Government.

SEC. 3. (a) There is hereby established an independent agency of the Federal Government to be known as the National Science Foundation (hereinafter referred to as the "Foundation"), and administered by an Administrator (hereinafter referred to as the "Administrator") who shall be appointed by the President, by and with the advice and consent of the Senate, and shall receive compensation at the rate of $15,000 per annum. The President shall appoint a Deputy Administrator, who shall perform the functions of the Administrator during his absence or when there is a vacancy in the office of the Administrator, and shall perform such other duties as may be delegated to him by the Administrator. The Deputy Administrator shall receive compensation at the rate of $12,000 per annum.

(b) There shall be within the Foundation a Division of Mathematical and Physical Sciences, a Division of Biological Sciences, a Division of Social Sciences, a Division of Health and Medical Sciences, a Division of National Defense, a Division of Engineering and Technology, a Division of Scientific Personnel and Education, a Division of Publications and Information, and such additional divisions, not to exceed three in number, as the Administrator may from time to time establish. The functions of each division shall be prescribed by the Administrator. Each division shall be headed by a Director, who shall be appointed by the Administrator and shall receive compensation at the rate of $12,000 per annum.

(c) Except as provided in section 4, the Administrator shall appoint and fix the compensation of such personnel as he may deem necessary to carry out the provisions of this Act. Such appointments shall be made and such compensation shall be fixed in accordance with the provisions of the civil-service laws and regulations and the Classification Act of 1923, as amended, except that, when deemed necessary by scientific, technical, and professional personnel may be employed without regard to the civil-service laws, and their compensation fixed without regard to the Classification Act of 1923, as amended.

National Science Board and Divisional Scientific Committees

SEC. 4. (a) The Administrator, in exercising his authority under this Act, shall consult and advise with a National Science Board (hereinafter referred to as the "Board") and, through the Directors of the several divisions, with divisional scientific committees, on all matters of major policy or program or budget. The Board shall consist of nine members appointed by the President, by and with the advice and consent of the Senate, from among persons who are especially qualified to promote the broad objectives of this Act, plus the chairman of the several divisional scientific committees. The scientific committee for each division, except the Division of National Defense, shall consist

of not less than five and not more than fifteen members appointed by the Administrator, with the approval of the Board, except that the initial members of each divisional scientific committee shall be appointed by the Administrator with the approval of the nine Board members appointed by the President.

The scientific committee for the Division of National Defense shall consist of not more than forty persons, of whom at least half shall be civilians appointed by the Administrator, and the remaining members shall be divided equally between such chiefs of services or divisions of the War Department and such chiefs of bureaus and offices of the Navy Department as the Secretary of War and the Secretary of the Navy, respectively, may from time to time designate. There shall be within the divisional scientific committee for the Division of National Defense a nine-man executive committee consisting of the chairmen of the divisional scientific committee, as chairman; four civilian members elected annually by the civilian members of the divisional scientific committee, together with two Army officers and two naval officers, one of each of whom should be charged in their respective Departments with the coordination of research, designated by the Secretary of War and the Secretary of the Navy, respectively.

Every effort shall be made to assure that each divisional scientific committee is representative of the major scientific interests and functions of its division. Members of the Board appointed by the President and members of the divisional scientific committees appointed by the Administrator shall serve for three-year terms, except that (1) at least one-third of such members originally appointed shall be appointed for one-year terms, and at least another third for two-year terms, and (2) any member appointed to fill a vacancy occurring prior to the expiration of the term of his predecessor shall be appointed for the remainder of such term.

No person who has served as a member of the Board or any divisional scientific committee shall be eligible again to serve as a member of the same group until the expiration of three years after his term has expired, except that a member appointed for a term of less than three years may be appointed for a succeeding three-year term.

(b) The Board and each divisional scientific committee shall annually elect its own chairman from among its own members, and shall deivse its own rules of procedure. The Board and each such committee shall meet at the call of its own chairman or at such times as may be fixed by itself, but in no event less frequently than once each month.

The Board shall appoint and prescribe the duties of an executive secretary of its own selection. The executive secretary, together with such clerical and professional assistance as may be determined by the Board to be necessary, shall assist the Board in carrying out its functions as described in this Act.

(c) The Board shall continuously survey the activities and management of the Foundation, and shall periodically evaluate the achievements of the Foundation in accomplishing the objectives of this Act. Each divisional scientific committee shall survey continuously the scientific field which it encompasses, shall undertake to determine the specific scientific needs of such field, and shall evaluate proposed programs and projects. The Board and each such committee shall, upon its own initiative or upon request by the Administrator, make appropriate recommendations and reports relating to its duties and findings. The Board and each such committee shall have full access to all information in the possession of the Foundation.

(d) The Board may, whenever it deems necessary, make such recommendations to the President and the Congress as in its opinion will further the objectives of this Act. The Administrator shall, whenever requested by the Board or any divisional scientific committee, publish and disseminate widely any recommendations or reports prepared by the Board or such committee. The Administrator shall render an annual report to the President and the Congress, summarizing the activities of the Foundation, together with such recommendations as he may deem appropriate. The annual report shall include such independent recommendations concerning the budget, the organization, and the management of the Foundation, and such other recommendations as the Board and the divisional scientific committees may deem necessary to better effectuate the purposes of this Act. The annual report shall include whatever dissenting opinions may be submitted for that purpose by individual members of the Board or the divisional scientific committees.

(e) Members of the Board and of the divisional scientific committees shall receive compensation at the rate of $50 for each day engaged in the business of the Foundation, and shall be reimbursed for their necessary travel and other expenses incurred in the work of the Board or of any such committee. Persons holding other offices in the executive branch of the Federal Government may serve as members of the Board or any divisional scientific committee, but they shall not receive remuneration for their services as such members during any period for which they receive compensation for their services in such other offices, nor shall they act in an official capacity for the Government agency by which they are employed

while they are serving as members of the Board or such committee.

(f) Members of the Board and of any divisional scientific committee established under the provisions of this Act, and any other officers or employees of the Foundation, shall be chosen without regard to their political affiliations and solely on the basis of their demonstrated capacity to carry out the purposes of the Foundation and their fitness to perform the duties of their office.

(g) The Administrator may create such specialized additional advisory committees or employ the services of part-time advisory personnel as he may deem necessary to better effectuate the objectives of this Act. Persons so engaged shall be reimbursed for their necessary travel and other expenses incurred in the work of the Foundation. Such persons may be noncompensated or may receive compensation at the rate not to exceed $50 for each day of service. Any person serving only in an advisory capacity pursuant to this section, including the members of the National Science Board and of the Divisional Scientific Committees, may serve as such without regard to the provisions of sections 109 and 113 of the Criminal Code (18 U.S.C., secs. 198 and 203) or section 19 (e) of the Contract Settlement Act of 1944, except insofar as such sections may under certain conditions prohibit any such person from receiving compensation in respect of any particular matter which directly involves the Foundation or in which the Foundation is directly interested; but nothing in this Act shall be construed to modify, impair, or restrict the application of section 41 of the Criminal Code with respect to any such person.

SUPPORT OF RESEARCH AND DEVELOPMENT

SEC. 5. (a) The Administrator is authorized to enter into contracts or other arrangements pursuant to which he will finance, in whole or in part, or otherwise support, research and development activities to be carried on by other Government agencies or by other organizations.

(b) Of the funds appropriated to the Foundation and expended by it for research and development activities, not less than 15 per centum shall be expended for research and development in each of the following fields: (1) National defense and (2) health and the medical sciences.

(c) Of the funds appropriated to the Foundation for research and development activities (excluding funds expressly appropriated for national defense), not less than 25 per centum shall be apportioned among the States as follows: Two-fifths shall be apportioned among the States in equal shares, and the remainder shall be apportioned among the States in the proportion that their respective populations bear to the population of all the States, determined according to the last preceding decennial census; and the amounts so apportioned to each State shall be expended by the Administrator only for carrying on research and development activities in the facilities of tax-supported colleges and universities, including the land-grant colleges, within such State. In making contracts or other financial agreements pursuant to this provision, the Administrator shall, consistent with such general program as he may establish in order to carry out the objectives and provisions of this Act, give each individual institution the widest latitude in its choice of individual research and development projects. For purposes of this section the term "State" includes Alaska, Hawaii, and Puerto Rico. Of the funds appropriated to the Foundation for research and development activities (excluding funds expressly appropriated for national defense), an additional per centum of not less than 25 shall be expended in the facilities of nonprofit organizations without regard to the above limitations relating to State quotas or the tax-supported character of the organization. In meeting the requirements of this subsection, the Administrator may take into account whatever funds may be expended by the Foundation for facilities to be operated by the land-grant, tax-supported, or other nonprofit organizations, even though the title or ownership rights of such facilities remain with the United States.

(d) The activities of the Foundation shall be construed as supplementing and not superseding, curtailing, or limiting any of the functions or activities of other Government agencies authorized to engage in scientific research and development. Funds allocated by the Administrator to other Government agencies shall be utilized for projects approved by the Administrator and undertaken on behalf of the Foundation, and shall be in addition to, and not in lieu of, funds regularly appropriated to such other Government agencies.

(e) In all research and development activities financed or otherwise supported by the Foundation, the Administrator shall make every effort to eliminate restraints upon the free expression of scientific views and to insure full freedom in the exercise of creative talents, in the development of new ideas and in the methods of research. Any person engaged in such research and development activities shall not be precluded from discussing, writing, or publishing his own findings and conclusions irrespective of such other arrangements for publication and dissemination as may be made by the Administrator.

Scholarships and Fellowships

Sec. 6. The Administrator is authorized to award scholarships and fellowships to persons for scientific study or scientific work at nonprofit institutions of higher education, or other institutions, selected by the recipient of such aid, for such periods as the Administrator may determine, in the United States or in foreign countries. Persons shall be selected for such scholarships and fellowships solely on the basis of aptitude, within the limits of such State quotas as may be established to insure an equitable selection of such persons from among the States. Persons selected for such scholarships and fellowships may include employees of the Federal Government and such employees selected and detailed for scientific study or training shall not lose their individual status or seniority ratings for reason of absence from regularly assigned duties during the course of such study or training.

Register of Scientific Personnel

Sec. 7. The Administrator shall maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information concerning all scientific and technical personnel in the United States and its possessions. No individual shall be listed in such register without his consent.

Use and Dissemination of Research Findings

Sec. 8. (a) The Administrator shall make and maintain an inventory of all current federally financed research and development projects. In cooperation with the Commissioner of Patents, the Administrator shall establish a central register of all inventions, discoveries, patents, patent rights, and findings, including references to related data, in which the United States or any agency thereof has any right, title, or interest, or which pursuant to this section have been freely dedicated to the public. The Administrator shall record, collect, edit, index, publish, and disseminate significant data on all inventions and discoveries and other findings produced in the course of federally financed research and development activities, or arrange with other Government agencies for such recording, collecting, editing, indexing, publishing, and dissemination. In consultation and collaboration with the Library of Congress and other Government agencies, the Administrator shall take such steps as he may deem necessary to make such information and other available significant scientific and technical information accessible to the public, including the preparation and distribution of periodic catalogs, inventories, abstracts, translations, bibliographies, and microfilm reproductions, of research and development projects, contracts, reports, and publications. In the publication of such information, the Administrator may utilize private publishing facilities to the extent that he deems necessary or desirable, without regard to the provisions of section 87 of the Act of January 12, 1895 (28 Stat. 622), and section 11 of the Act of March 1, 1919 (40 Stat. 1270) (U. S. C., title 44, sec. 111).

(b) Each contract for federally financed research or development entered into between any Government agency and any organization shall provide that such organization will make available to such agency full data on all inventions, discoveries, patents, patent rights, processes, and findings produced in the course of such research or development, including such reports with respect thereto as may be required by such agency. Each Government agency, upon the request of the Administrator, shall make available to him such data and such reports with respect to research and development activities financed by such agency, as may be necessary for the purposes of subsection (a).

(c) Except as provided in subsection (d) below, all rights in inventions, discoveries, or patents now or hereafter owned by or vested in the United States or any Government agency shall be freely dedicated to the public, and any invention, discovery, patent, patent right, or finding hereafter produced in the course of federally financed research or development shall be freely dedicated to the public.

(d) The head of any Government agency financing by contract, or otherwise administering, federally financed research and development activities (including the Administrator in the case of the Foundation) may, by stipulation in the contract or by other advance agreement with any organization (other than a nonprofit organization), provide for the retention by the contractor or by the inventor, or by their assignees, of such patent rights as the head of such agency deems fair and equitable and consistent with the national interest: *Provided,* That—

(1) such retention is in a field specified in the contract and as to which field the head of such Government agency has made a formal finding, prior to entering into such contract or other advance agreement that such field has been developed substantially as the result of earlier research or development activities of the contractor which were not federally financed; or

(2) a later finding is made, pursuant to such procedures as may be specified in the contract or other advance agreement, that the particular invention, discovery, patent, patent right, process, or finding has been developed substantially as the result of earlier research or development activities of the contractor which were not federally financed; or

(3) the contractor or other recipient of financial assistance from the Government for research and development is currently contributing substantially to the cost of the particular research and development project.

In making any stipulation in a contract or other advance agreement pursuant to this subsection, the head of the Government agency shall, in determining what is deemed fair and equitable and in the national interest, be guided by the following principles: (1) That the Government's interest is served best by making fully available to all users at the lowest possible charge any invention, discovery, or finding which may result from such federally financed research or development; (2) that whenever there are two or more facilities of comparable suitability available to meet the Government's needs, the facility which requires no retention or least retention of commercial rights pursuant to this subsection shall be selected. Any contract or advance agreement made pursuant to this subsection shall in every case provide for at least an irrevocable, nonexclusive, royalty-free license for governmental purposes to the United States under all inventions, discoveries, patents, or findings produced in the course of the research and development contracted for.

(e) The head of each Government agency shall make a quarterly report to the President and to the Congress concerning contracts containing the provisions authorized by subsection (d), and shall include a list of all contracts containing such a provision entered into by such agency during the preceding quarter, the reasons supporting the approval of such provision in each case, the amount of Federal funds expended or to be expended under each contract containing such a provision, the name of the organization receiving the contract, and the general nature of the patent rights reserved for private use in each such contract.

(f) Notwithstanding any other provision of this Act, the President, or any person designated for that purpose by him, may exempt from the provisions of this Act relating to dedication to the public, publication, or dissemination, any scientific or technical information, data, patents, invention, or discoveries produced in the course of federally financed research or development, if and so long as the President or such designated person determines that such exemption is essential in the interest of national security.

International Development of Science and International Exchange of Scientific and Technical Information

Sec. 9. (a) The Administrator is hereby authorized with the approval of and through the Department of State to conclude agreements with foreign governments or agencies thereof relating to the exchange of scientific and technical information to facilitate the maximum acquisition, dissemination, and use thereof. The Administrator may, whenever he deems it necessary to promote the objectives of this Act, defray the expenses of representatives of Government agencies and other organizations to accredit international scientific congresses and meetings.

(b) The Administrator is hereby authorized, with the approval of and through the Department of State, to cooperate in any international research or development activities consistent with the purposes or provisions of this Act and to allocate and expend for such international research activities, such sums, within the limit of appropriated funds, as the Administrator may deem desirable.

Interdepartmental Coordination

Sec. 10. (a) There is hereby established an Interdepartmental Committee on Science, to consist of the Administrator, as Chairman, and the heads (or their designees) of such Government agencies engaged in or concerned with the support of scientific activity to a substantial degree as the President may from time to time determine. The Interdepartmental Committee shall meet whenever the Chairman so determines, but not less than once a month.

(b) The Interdepartmental Committee shall advise and assist the Administrator in gathering and correlating data relating to the scientific research and development activities of the Federal Government; shall study and evaluate such data in relation to the program of the Foundation and the scientific research and development programs of the other Government agencies; and shall make such recommendations to the Foundation and other Government agencies and to the President as in the opinion of the Committee will serve to aid in effectuating the objectives of this Act and other legislation providing for Federal support of scientific research and development. The Administrator, in consultation with the Interdepartmental Committee, shall, from time to time, make recommendations to the President for the achievement of maximum effectiveness in the conduct of all federally financed research and development.

Miscellaneous

Sec. 11. (a) To enable the Administrator to carry out his powers and duties, there is hereby authorized to be appropriated annually to the Foundation, out of any money in the Treasury not otherwise appropriated, such sums as may be necessary to carry out the provisions of this Act. The funds appropriated to the

Foundation, as herein authorized, and funds hereafter appropriated to any Government agency for scientific research or development, as herein defined, shall, if obligated during the fiscal year for which appropriated, or if reserved for a project expected to continue beyond the end of such year, remain available for expenditure for four years following the expiration of the fiscal year for which appropriated. After such a four-year period, the unexpended balances of appropriations shall be carried to the surplus fund and covered into the Treasury.

(b) The materials or equipment purchased by Federal funds or furnished by the Federal Government in connection with research and development activities shall be the property of the United States. The Administrator shall not, however, through the Foundation or its own employees, operate any laboratories, pilot plants, or other such scientific or technical facilities which he may acquire.

(c) In carrying out his functions under this Act, the Administrator is authorized—

(1) to prescribe such rules and regulations as he deems necessary governing the manner of the operations of the Foundation and its organization and personnel;

(2) to enter into contracts, or amendments or modifications of contracts, without performance or other bonds, and without regard to section 3709 of the Revised Statutes (U. S. C., title 41, sec. 5) in the case of all contracts which relate to scientific research or development;

(3) to make advance, progress, and other payments which relate to scientific research or development without regard to the provisions of section 3648 of the Revised Statutes (U. S. C., title 31, sec. 529);

(4) to acquire by purchase, or otherwise, hold and dispose of by sale, lease, loan, or otherwise, real and personal property of all kinds necessary for, or resulting from, scientific research or development;

(5) to prescribe, with the approval of the Comptroller General of the United States, the extent to which vouchers for funds expended under contracts for scientific research and development shall be subject to itemization or substantiation prior to payment, without regard to the limitations of other laws relating to the expenditure of public funds and accounting thereof.

(d) The following statutes, limiting the character and distribution of Government publications, attendance at scientific and professional conferences by Government employees, the purchase of literature by Government agencies, and related matters, shall not apply to the Foundation or, insofar as funds allotted by the Foundation may be used by any Government agency, to the use of such funds by any such agency: That cause of section 61 of the Act of January 12, 1895 (28 Stat. 601, 610; 44 U. S. C., sec. 71) reading "but only one copy of any document shall be sold to the same person, excepting libraries or schools by which additional copies are desired for separate departments thereof, and Members of Congress"; section 92 of the Act of January 12, 1895 (28 Stat. 601, 623), as amended by section 8 of the Act of August 23, 1912 (37 Stat. 360, 414; 44 U. S. C., sec. 95); section 87 of the Act of January 12, 1895 (28 Stat. 601, 622), as amended by the second proviso of section 11 of the Act of March 1, 1919 (40 Stat. 1213, 1270; 44 U. S. C., sec. 111); that part of section 1 of the Act of March 3, 1905 (33 Stat. 1156, 1213), which is codified as Forty-fourth United States Code, section 118; section 94 of the Act of January 12, 1895 (28 Stat. 601, 623; 44 U. S. C., sec. 219); that part of section 1 of the Act of March 3, 1905 (33 Stat. 1214, 1249), which is codified as Forty-fourth United States Code, section 219a; the first proviso of section 11 of the Act of March 1, 1919 (40 Stat. 1213, 1270); section 8 of the Act of June 26, 1912 (37 Stat. 139, 184; 5 U. S. C., sec. 83); section 192 of the Revised Statutes, as amended (5 U. S. C. 102); and section 177 of the Revised Statutes (5 U. S. C. 102).

Definitions

Sec. 12. As used in this Act—

(a) "Research and development" means theoretical analysis, exploration, and experimentation in any field of science (including but not limited to the mathematical, physical, biological, medical, and social sciences) and the extension of investigative findings and theories of a scientific or technical nature into practical application, including the experimental production and testing of models and processes.

(b) "Federally financed research and development" means research and development financed in whole or in part from funds designated for research and development by the Federal Government under a contract, grant, or other form of financial assistance.

(c) "Government agency" includes departments, independent agencies and commissions, corporations, and other instrumentalities of the Federal Government.

(d) "Organizations" includes State and local government agencies, corporations, partnerships, non-profit institutions, and individuals.

(e) "Scholarships and fellowships" means stipends covering tuition and other fees, and such living, travel, and other expenses as the Administrator may determine.

Committee for a National Science Foundation

The text of a statement prepared by the Committee for a National Science Foundation appeared in these columns last week (*Science*, 1946, **103**, 11). The following list of names constituting the original signers is now available from the Committee, whose address is Room 170, Hotel Astor, New York City:

C. A. Adams, engineer, E. G. Budd Manufacturing Company, Philadelphia; Charles C. Adams, New York State Museum, Albany; C. R. Adams, professor of mathematics, Brown University; T. Addis, professor of medicine, Stanford Medical School, California; Harold L. Alden, Leander McCormick Observatory, University of Virginia; William Phelps Allis, professor of mathematical physics, Massachusetts Institute of Technology; I. Amdur, Department of Chemistry, Massachusetts Institute of Technology; Thomas F. Anderson, Johnson Foundation, University of Pennsylvania; Donald H. Andrews, professor of chemistry, Johns Hopkins University; Robert C. Angell, Department of Sociology, University of Michigan; Frank Aydelotte, Institute for Advanced Study, Princeton, New Jersey.

E. Wight Bakke, Institute of Human Relations, Yale University; C. Canby Balderston, Wharton School of Finance and Commerce, University of Pennsylvania; Edward Bartow, emeritus professor of chemistry, State University of Iowa; Charles H. Behre, Jr., professor of geology, Columbia University; Raphael A. Bendove, Columbia University Medical School; Ruth Benedict, professor of anthropology, Columbia University; Wendell C. Bennett, professor of archaeology, Yale University; Charles P. Berkey, emeritus professor of geology, Columbia University; Gordon W. Blackwell, Department of Sociology, North Carolina; David P. Boder, professor of psychology, Institute of Technology, Chicago; H. Dean Baker, Pupin Physics Laboratory, Columbia University; J. Lloyd Bohn, professor of physics, Temple University; Bart J. Bok, Harvard Observatory; Edison L. Bowers, Department of Economics, Ohio State University; Ernest W. Burgess, professor of sociology, University of Chicago; H. T. Briscoe, professor of chemistry, Indiana University; Allan M. Butler, Harvard Medical School.

Walter G. Cady, professor of physics, Wesleyan University; Frank K. Cameron, professor of chemistry, University of North Carolina; Leon Campbell, Harvard Observatory; Robert C. Challman, Division of Research, Norwich State Hospital; W. Edward Chamberlain, Department of Radiology, Temple University; Robert Chambers, professor of biology, New York University; Agnes Chase, Smithsonian Institution, Washington, D. C.; E. Chittenden, professor of mathematics, State University of Iowa; Richard G. Clarke, professor of chemistry, Wesleyan University; Charles H. Colvin, aeronautical engineer, 320 Central Park West, New York City; Edward G. Conklin, professor of zoology, Princeton University; Morris Llewellyn Cooke, Hay-Adams House, Washington, D. C.; John M. Cooper, professor of anthropology, Catholic University; Leonard S. Cottrell, Jr., Chairman, Department of Sociology and Anthropology, Cornell University; Richard Courant, professor of mathematics, New York University; E. V. Cowdry, professor of anatomy, Washington University Medical School; R. Tracy Crawford, professor of astronomy, University of California; Harry Curtis, Dean of Engineering, University of Missouri; Howard J. Curtis, Monsanto Chemical Company, Knoxville, Tennessee.

Leo M. Davidoff, Chief, Department of Surgery, Jewish Hospital, Brooklyn; Kenneth S. M. Davidson, Director, Experimental Towing Tank, Stevens Institute of Technology; M. Demerac, Carnegie Institution, Cold Spring Harbor, New York; Dr. Moses Diamond, embryologist, Columbia Dental School; Theodore Dobzhansky, professor of zoology, Columbia University; John Dollard, research associate, Institute of Human Relations, Yale University; L. C. Dunn, Department of Zoology, Columbia University; John R. Dunning, professor of physics, Columbia University.

A. Einstein, Institute for Advanced Study, Princeton, New Jersey; Robert Elman, professor of surgery, Washington University Medical School.

Kasimir Fajans, professor of chemistry, University of Michigan; I. Fankuchen, professor of physics, Brooklyn Polytechnic Institute; Marie Farnsworth, chemist, Metal and Thermit Corporation, Rahway, New Jersey; George E. Farrar, Jr., Temple University Medical School; Enrico Fermi, professor of physics, Nuclear Institute, University of Chicago; E. D. Friedman, 1192 Park Avenue, New York City.

A. L. Garbat, attending physician, Lenox Hill Hospital, New York City; Frederick J. Gaudet, Veterans Administration Guidance Center, Stevens Institute of Technology; John M. Gaus, professor of political science, University of Wisconsin; Samuel Gelfan, physiologist, 80 Haven Avenue, New York City; R. W. Gerard, professor of physiology, University of Chicago; James Gilluly, professor of geology, University of California at Los Angeles; Clarence H. Graham, professor of psychology, Columbia University; David M. Grayzel, pathologist, Jewish Hospital, Brooklyn; Harry Grundfest, Columbia University Medical School; Ralph H. Gundlach, professor of psychology, University of Washington; R. G. Gustavson, Vice-president, University of Chicago.

Danforth R. Hale, RCA Manufacturing Company, Harrison, New Jersey; Calvin S. Hall, professor of psychology, Western Reserve University; Robert B. Hall, professor of geography, University of Michigan; A. Irving Hallowell, professor of anthropology, Northwestern University; H. B. Hass, professor of chemistry, Purdue University; Ernst Hauser, professor of chemistry, Massachusetts Institute of Technology; Michael Heidelberger, Columbia University Medical School; C. Judson Herrick, professor of neurology, University of Chicago; Melville J. Herskovits, professor of anthropology, Northwestern University; Max Hertzman, professor of psychology, College of the City of New York; Joel H. Hildebrand, professor of chemistry, University of California; John Hill, Assistant Curator, American Museum of Natural History, New York City; T. R. Hogness, professor of chemistry, University of Chicago; Pryns Hopkins, Claremont College, Pasadena, California; Harold Hotelling, professor of economics, Columbia University; Maurice L. Huggins, research chemist, Eastman Kodak Company, Rochester, New York; W. S. Hunter, professor of psychology, Brown University; Harold Thomas Hyman, Monmouth Memorial Hospital, Long Branch, New Jersey.

Herbert R. Isenburger, Department of Physics, Columbia Uuiversity.

Preston E. James, professor of geography, University of Michigan; T. Duckett Jones, Harvard Medical School; Warren C. Johnson, professor of chemistry, University of Chicago.

John S. Karling, professor of botany, Columbia University; Joseph H. Keenan, professor of mechanical engineering, Massachusetts Institute of Technology; Foster Kennedy, professor of neurology, Cornell Medical College; Frederick G. Keyes, professor of chemistry, Massachusetts Institue of Technology; Paul Kirkpatrick, professor of physics, Stanford University; Morris Kline,

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News and Notes

Dr. Doncaster G. Humm has been elected president of the Southern California Academy of Criminology, an organization founded about twenty-five years ago by August Vollmer.

Dr. G. W. Fox, professor of physics at Iowa State College, has been named technical adviser to Gen. Douglas MacArthur and probably will spend about three months in Japan. Dr. Fox, working with one other scientist, will advise Gen. MacArthur as to which scientific activities should be encouraged in Japan and which, if any, should be discouraged.

Dr. H. E. Hayward has been appointed director of the U. S. Regional Salinity Laboratory, Riverside, California, succeeding Dr. O. C. Magistad, who resigned to assume the direction of research for Libby, McNeill, & Libby in Hawaii. Dr. Hayward has been associated with the Salinity Laboratory since 1939, working on the salt tolerance of agricultural crops and the effect of saline substrates on the entry of water into roots.

Dr. Lloyd W. Morris, who recently returned to his post as professor of physics at Louisiana State University after three years war research on radar and proximity fuses, delivered an address before the Louisiana State Chapter of the Society of the Sigma Xi on 20 November. His subject was: "Can Pure Science Be Defended?"

Dr. Dexter French, research chemist at the Corn Products Refining Company, has been appointed research assistant professor of plant chemistry at Iowa State College.

Major John F. Sandfort, who has been on leave from the Department of Mechanical Engineering, has returned to his duties at Iowa State College.

Dr. C. Lee Huyck, formerly research chemist in charge of developing new products for the William S. Merrell Company, has recently joined the research staff of the Winthrop Chemical Company, Rensselaer, New York, in the capacity of senior pharmacist.

Lt. Col. William Reiner-Deutsch, Sn. C., lately executive officer of 191st General Hospital in Paris, has returned to the United States.

Dr. Ernest B. Benger, general assistant manager of the Technical Division of the Rayon Department of the Du Pont Company, has been appointed manager of the division, succeeding M. du Pont Lee, who was recently named general consultant in the Engineering Department, the company announced on 6 December 1945. A. E. Buchanan, Jr., continues in his present capacity as assistant manager of the Technical Division.

Dr. Robert L. Pendleton, technical consultant in soil science for the Office of Foreign Agricultural Relations, U. S. Department of Agriculture, has recently returned to Washington after ten months study of soils and land-use problems in Peru, Ecuador, the Canal Zone, Nicaragua, El Salvador, and Guatemala.

Dr. Robert E. Allen, who recently obtained his Ph.D. at the University of Illinois, has joined the Research Laboratories of The Wm. S. Merrell Company, Cincinnati, Ohio. Dr. Allen has been carrying out research work in the field of chemistry for the Office of Scientific Research and Development.

Announcements

Battelle Memorial Institute has announced that the release of its laboratories and staff from critical war research is being accompanied by a gradual resumption and expansion of its fundamental research. This type of research, which prior to the war always held a prominent place in Battelle's activities, is sponsored by the Institute itself as a public service and proceeds concurrently with industrially-sponsored work.

As in previous years, Battelle's fundamental research will be conducted both by members of the permanent staff and by specially-appointed research fellows. Fundamental investigations by its permanent staff are now in progress in the fields of physics, metallurgy, welding, and electrochemistry. Research fellows who have been appointed recently are conducting investigations in the fields of chemistry and electrochemistry.

Battelle fellowships are designed for graduates in the physical sciences who wish to pursue postgraduate work in preparation for careers in industrial and scientific research. By cooperative arrangement with participating universities, the fellow pursues academic work in a recognized graduate school and conducts his research for his thesis in the laboratories of the Institute. The problems investigated by Battelle fellows are, of course, problems in fundamental science.

A major fundamental research investigation undertaken by the Institute is the study of techniques for using the electron microscope in the examination of metallic and ceramic materials. A new RCA research model electron microscope was installed recently for use in this connection. The program is a long-range one, having as its objective the revealing of informa-

tion which will widen the scope of usefulness of the electron microscope.

According to Director Clyde Williams, several years may be required for the full realization of the Institute's fundamental research plans. Much will depend on the manpower and equipment which can be made available for such studies. He also pointed out that many of the industrially-sponsored investigations at Battelle contribute directly to fundamental science. This is particularly true in the case of projects sponsored by research associations or groups of like industries banded together for the solution of problems basic to each industry. Quite often the solution to a strictly technological problem involves the solution of scientific problems underlying it.

The Pontifical Academy of Sciences has undertaken to compile a general report of the scientific research work accomplished throughout the world from 1939 to the present day. The Academy appeals, therefore, to its own members and to such scientists as are qualified to assist, asking them for their collaboration in this project, which ought to be carried through in the shortest possible time if it is to attain the object in view.

The general report will consist of a series of particular reports referring to one or more countries and will treat various branches of science, following a distribution normally to be determined by the best-known scientific journals or reports as selected by the author.

Each report should comply with the following rules: 1) It should be concerned with publications issued from 1 January 1939 up to the time of the report; 2) it should be preceded by a synthetic presentation of the situation of the scientific branch considered in the country or countries to which the study refers; 3) it should relate the most important results attained; and 4) it should include a bibliography of as many works as possible, properly classified, even if they do not refer to the researches described in the general part of the report.

Arrangements are being made for shipment of the material to Vatican City through the Apostolic Delegation in Washington, and men engaged in every field of scientific endeavor are asked not only to submit reports but also to send manuscripts and reprints of their publications, especially reviews, to Dr. Piero P. Foà, Chicago Medical School, 710 South Wolcott Avenue, Chicago, Illinois.

The Educational Committee of the National Bureau of Standards, in the course of its regular program of graduate instruction, announces the following courses for the present academic year: Electricity and Magnetism, Dr. Allen V. Astin; Differential Equations, Mr. Samuel Levy; Petrographic Methods, Dr. Willard H. Parsons; and Advanced Physical Chemistry, Dr. Walter J. Hamer. Each course comprises 60 lecture hours, and academic credit is given.

In addition, the two following symposia of 60 hours each are being presented this year, attendance at which is not subject to the usual academic regulations: Physical Methods in Chemical Analysis, under the direction of Dr. G. G. Manov; Properties of High Polymers, under the direction of Dr. R. Simha.

A number of active workers in the field from academic institutions and industrial laboratories in the country are participating as lecturers, together with members of the Bureau staff.

Paul Rosenberg Associates, consulting physicists, have announced the opening of offices in the Woolworth Building in New York City. Work will be done in radar, ultrasonics, television, optics, nuclear physics, and general physics. The head of the consulting firm, Paul Rosenberg, who before the war was lecturer in physics at Columbia University, has just completed four years war work with the Radiation Laboratory of the National Defense Research Committee at the Massachusetts Institute of Technology.

Journal of the History of Medicine and Allied Sciences, a new Quarterly published by Henry Schuman, 20 East 70th Street, New York 21, N. Y., appears this month under the editorship of Dr. George Rosen. The Editorial Board, in addition to Dr. Rosen, consists of Drs. Erwin H. Ackerknecht, Max H. Fisch, John F. Fulton, and Josiah C. Trent, and is to be assisted by forty-three consulting editors, approximately half of whom are located in various foreign countries.

The publisher states that the aims of the new Quarterly are: "(1) to help medical men better understand daily tasks through a knowledge of the history of the medical past, and (2) to provide cultural stimulation and pleasurable moments for those to whom medical history is a hobby and a joy."

The cost of an annual subscription is $7.50 in the United States, Canada, and Latin America, $8.50 elsewhere.

Conferences at the Hague are now taking place between Netherlands educators and scientists and the members of a delegation from the United States, which includes professors from leading colleges and Government experts as well as six U. S. Army officers. The American visitors were officially received at Amsterdam University by the Rector Magnificus and Feike de Boer, mayor of Amsterdam. Additional meetings will be held in Utrecht, Rotterdam, and other cities.

Technical Papers

Electrical Correlates of Peripheral Nerve Injury: A Preliminary Note[1]

R. G. Grenell and H. S. Burr
Yale University School of Medicine

In 1936 Burr, Lane, and Nims (*1*) described a new technic for the measurements of bioelectric phenomena. Their method was designed to discover whether or not living organisms possess potential differences, and, if so, to measure such differences independently of resistance changes and current flow. Further investigation showed that the apparatus met the ideal requirement, *i.e.* high input impedance (minimal current drain from the tissue), high stability, and high sensitivity. With this equipment available, the present experiments were undertaken to study potential differences of peripheral nerves (and of skin-surface areas) before and after injury and during degeneration and regeneration.

Three general types of experiments have been performed on rabbits and one on human cases, the sciatic nerve being used in all rabbit experiments and the ulnar nerve in the tests on human subjects: (1) direct measurements on peripheral nerve under various conditions; (2) measurements of limb surface EMF with the peripheral nerve undisturbed or blocked anatomically (nerve crushed or severed); and (3) measurements of limb surface EMF following physiological nerve block with procaine.

In all cases, measurements were made by means of the Burr-Lane-Nims microvoltmeter, described by them in 1936. Reversible, nonpolarizable, Ag-Ag Cl_2 brush electrodes were used, skin contact being assured by use of a salt electrode paste. The recorded data are in millivolts of potential difference between an indifferent electrode and an electrode moved from point to point along either a nerve or skin area.

In the first series of experiments, the sciatic nerve of the anesthetized rabbit was exposed in the thigh, and potential differences between an indifferent electrode on the skin of the leg and four selected points along the nerve proper were recorded. The second type of experiment involved similar measurements on the limb surface under normal conditions as well as following section or crushing of the nerve at the mid-point of the exposed area.

In the third series, rabbit sciatic nerves were infiltrated with 3 cc. of 4-per cent procaine without exposure of the nerve; in the human, ulnar nerves were infiltrated at the elbow with 3 cc. of 0.5- or 1-per cent procaine (in a few cases a procaine-adrenaline mixture was used). Records were made prior to injection, and following injection until the effects of the block had worn off.

The initial experiments in which measurements were made directly on the sciatic nerve in rabbits showed unequivocally that a potential gradient along the nerve is present. Distal points are negative to proximal. If the nerve is crushed so that the sheath is torn or traumatized, an injury potential is obtained (*i.e.* there is the expected peaking of the curve in the injured area).

Data obtained in the second type of experiment indicate that the potential differences recorded from the surface of the limb were modified by, or correlated with, the state of the peripheral nerve supplying the area. The acute effect of nerve section is a reversal in polarity of surface potentials.

These results led to an attempt to discover whether functional nerve block would be reflected in the surface measurements in a manner similar to physical or anatomical injury. In the rabbit, a series of six points on the skin, placed along the distribution of the sciatic nerve, showed a tendency toward significantly altered potentials following procaine injection of the nerve trunk. An hour following infiltration, many of these points showed a reversed polarity of considerable magnitude. This condition lasted for 45 minutes. Following this was a fall in potential until after the lapse of slightly more than two hours, when the potentials returned to approximately normal. This type of response is entirely absent when the degenerated sciatic nerve of the rabbit is infiltrated with procaine.

The results were so striking that a similar experiment was performed on human subjects. In these cases, three points were chosen along the hypothenar eminence lying within the area of distribution of the ulnar nerve. In the normal subject, as in the experimental animals, these three points show a marked shift in the measured potential difference.

In the case illustrated (Fig. 1), within 25 minutes after infiltration of the ulnar nerve with procaine, these three points were markedly positive. Twenty-five minutes later, with the return of flexor function, the potentials had dropped very considerably and continued to drop through the return of sensation and,

[1] The rabbits used in this study were provided in part under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Yale University School of Medicine. The study was aided by a grant from the Fluid Research Fund of the latter institution.

after the lapse of three hours, had returned to their normal relationships. This can be clearly seen in Fig. 1. The polarities represented here are those of the moving electrode.

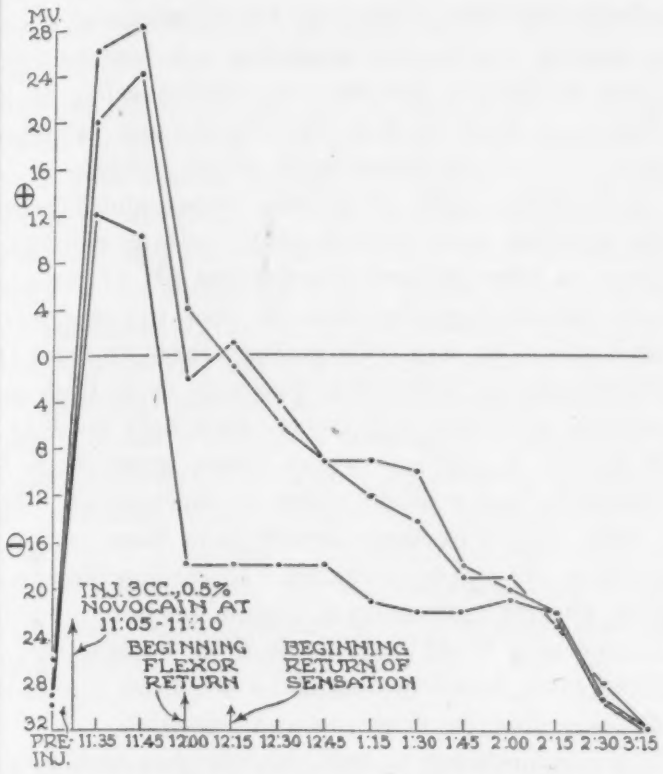

FIG. 1. Effects of left ulnar nerve block in man following injection of 3 cc. of 0.5-per cent novocain-suprarenin (1 : 50,000).

In man, procaine block produces changes of as much as 50–60 mv in the surface EMF of the functionally disturbed area. The curves in the human cases are much more striking than those of the rabbits, perhaps due in part to the fact that the rabbit nervous system was partially depressed, initially, by anesthesia.

It is clear from the results of these experiments that the condition of the peripheral nerve is reflected in the changing surface potential differences. The mechanism through which these changes are brought about is now being studied, and a clinical test for peripheral nerve injury is being developed.

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Spinal Conditioning in Dogs

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One of the most striking observations of recent years in the field of psychology and neurophysiology has been the observation that learning—or what appears to be learning of a rudimentary sort—can occur in the caudal extremities of higher vertebrates after the spinal cord has been completely transected. This would seem to mean that the organism, or a fragmentary part of it, can form simple associations without the aid of the cerebrum or of any of the higher centers of the central nervous system, and that these centers are therefore unnecessary for the occurrence of learning of the sort indicated.

The most extensive series of investigations on this topic has been conducted by Culler and Shurrager (*1, 2, 3, 4*), who used *acute* spinal dogs as experimental subjects. Their method was to pair an electric shock to the tail (the conditioned stimulus) with an electric shock to the foot (the unconditioned stimulus). Before training, the shocks to the tail produced no observable response in the flexing (semitendinosus) muscle of the leg; but after pairing of the conditioned and unconditioned stimuli, the tail shocks by themselves would then cause the semitendinosus muscle to contract.

We wish to report here some recent experiments at Indiana University in which conditioned-reflex training of a similar nature was attempted with *chronic* spinal dogs. A more complete account of the findings will appear subsequently in the psychological journals.

The conditioned stimulus in the present experiments was an electric shock to the left rear foot, and the unconditioned stimulus was a shock to the right rear foot. The response to be conditioned was the moving or flexing of the entire right hind limb. Each of the subjects was given 1,000 conditioning trials in groups of 100 trials each, spaced on alternate days over a period of about three weeks.

Despite the differences in experimental technique between the two investigations, there was clear evidence in each of our preparations that a muscle twitch or instantaneous jerk of the right rear leg could be evoked by the conditioned stimulus to the left rear foot. The twitch response was small in amplitude and of very short latency. We assume this twitching movement of the right rear member to be the same as the spinal conditioned response observed in the acute preparation by Shurrager and Culler.

The twitch response observed in our chronic spinal animals, however, was only a part of the behavior elicited by the conditioned stimulus. The records of movement of the right hind limb also disclosed a second and conflicting type of reaction. In place of the muscle twitch or incipient *flexion* there often occurred an *extension* of the right rear limb, *i.e.* the crossed extension reflex. Although the extension response was initiated immediately by the conditioned shock, it usually lasted for from two to three seconds. With respect to duration it had no resemblance, therefore, to the very brief jerk of the flexing muscles.

The two sorts of reflex movements were antagonistic and mutually inhibitory. They never occurred together on the same trial. One response would usually pre-

dominate for several trials and then be superseded by the other. Yet there can be no doubt that both responses were genuine and also that they were unstable (appearing and disappearing) even though the stimulating conditions remained the same.

Frequency graphs of the flexing twitch as well as of the extension response were so irregular that they were quite unrecognizable as learning curves. The only similarity to the typical curve of learning was that each response was absent at the start of training and increased somewhat in frequency during the later trials. When both the crossed extension and the flexion reactions were considered together, the combined frequency of responsiveness for all animals rose gradually for the first 300 trials (*ca.* one week) and continued at approximately 20 per cent responsiveness for the remaining 700 trials (*ca.* the two additional weeks).

In spite of this irregular level of about 20 per cent which persisted when both responses for all subjects were pooled, we could find no evidence of retention, over the intervals between experimental sessions, in the behavior of any one individual considered by itself. It should be clear, moreover, that the spinal behavior of the present subjects cannot be satisfactorily fitted into the conditioning formula, since that behavior was a combination of two antagonistic responses, now one occurring, now the other.

The conclusion to be drawn from these results is certainly not that spinal conditioning must be some sort of an artifact, but simply that we have not been able to establish it in chronic spinal animals under the conditions of the present experiments. The fluctuating responses of our preparations seem to us to be more adequately described as temporary changes in reflex behavior.

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A Gastric Mucigogue Action of the Alkyl Sulfates

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The continued introduction of new remedies for the management of gastric and duodenal ulcer is sufficient evidence that the last word on such remedies has not been written. In the past the problem has been concerned chiefly with the effect of the extrinsic agent upon gastric acidity and to a less extent with its effect on peptic activity. Certain of the detergents have recently attracted attention on account of their anti-peptic action. The present studies supply the first evidence that these detergents can stimulate an intrinsic gastric mechanism—secretion of mucus—which serves to protect the mucosa, mechanically, by its antacid effect, as well as to enhance any antipeptic activity which the agent itself might possess.

In a recent series of articles Shoch and Fogelson (*8*) reported that sodium alkyl sulfate inactivates pepsin *in vitro* without altering the pH of the solution; that it does the same *in vivo* (*9*) and, when administered to dogs with gastric ulcers produced experimentally by histamine, prolongs their lives considerably (*9*); and that it gave strikingly good clinical results in patients whose ulcers appeared to be intractable under other forms of therapy (*2*). The *in vitro* effects of these agents have been confirmed by others (*4*) and by ourselves. Regarding the *in vivo* effect, no such uniformity of results has been reported. Kirsner and Wolff (*5*), as well as Steigmann and Marks (*10*), failed to obtain the beneficial clinical results described by Fogelson and Shoch.

On administering to rats either of two highly purified products,[1] sodium dodecyl sulfate (C_{12}) and sodium "Lorol" sulfate (a mixture of C_{12} chiefly plus some C_{14} and C_{16}), we observed in many of the animals a copious gastric secretion which appeared to be very rich in mucus. These results will be reported elsewhere. In view of the importance of mucus and its specific component, mucin, in protecting the gastric mucous membrane from destruction (ulceration) by the gastric juice, we were especially interested in the mucigogue action of the aforementioned agents. To determine whether these agents act similarly in other animal species and also to obtain adequate quantities of mucus for study, we conducted experiments on dogs, the results of which form the substance of this report.

In fasting dogs under nembutal anesthesia, the stomach was isolated by ligation of the esophagus in the neck in conjunction with ligation of the pylorus either alone or with the addition of a ligature around the antrofundal juncture, according to a technique previously described (*6*). The latter procedure established a pyloric and a main stomach compartment. The whole stomach or the compartments were fistulized, as the case might be. The whole stomach or the pouches were lavaged thoroughly with saline at 38° C until the last lavage returned clear (2 to 4 lavages). The gastric contents were then allowed to drain and when the secreted material was represented only by

[1] Supplied through the courtesy of Dr. J. H. Shipp, Fine Chemicals Division, E. I. du Pont de Nemours Company.

alkaline mucus, a control specimen of an hour's secretion was then collected, in 15-minute fractions for the dodecyl sulfate or sodium "Lorol" sulfate in saline or distilled water, warmed to body temperature, was then introduced slowly through the fistula. The quantity introduced was sufficient to fill the whole stomach or pouch at a pressure of 5 to 6 cm. of water. The test agent was allowed to remain in the stomach at this pressure for 1 to 1.5 hour. The gastric contents were drained completely, and the gastric secretion was collected. A 2-per cent solution of sodium first hour and subsequently in 30- or 60-minute fractions for an additional 2 or 3 hours. The specimens were analyzed for mucin by two methods[2] (gravimetric and colorimetric) developed in our laboratory. Since the gastric secretion following the introduction of the alkyl sulfates was always alkaline, the alkalinity was determined—by acidification, followed by removal of CO_2 and back titration with alkali. Pepsin was determined by Nierenstein's and Schiff's modification (*7*) of Mett's method; and pH was determined colorimetrically and, when possible, with the glass electrode, using the Beckman pH meter.

In the evaluation of the effects of the sodium alkyl sulfates upon gastric secretory function, two phases can be distinguished: (1) immediate effect, as reflected in the composition and physical properties of the instilled solution while in the stomach; (2) aftereffect, as manifested by the secretory response of the mucous membrane after the stomach is emptied.

The volume of fluid recovered from the stomach after 1 to 1.5 hour was never greater than the volume of fluid instilled. On the contrary, when the instillate was an aqueous (hypotonic) solution of the detergent, a small decrease (about 7 per cent) in the volume of the gastric contents was actually observed. Although the aqueous alkyl sulfate solution, when introduced into the stomach, contained no chloride, the gastric contents recovered contained a considerable amount (e.g. 38.9 m.eq. for the experiment illustrated in Fig. 1). They were quite viscous and contained much mucin (0.21 per cent).

The volume of mucus secreted during this period could not be determined directly but could be calculated. If we assume that the mucus secreted during the period in which the alkyl sulfate solution was in the stomach had the same concentration of glucuronic acid derivatives as that secreted for the second hourly period following the withdrawal of the test solution, the volume of mucus added to the instillate by the stomach mucosa was fairly large (e.g. for Dog 4 in the experiment illustrated in Fig. 1, 25.5 cc.). Similar calculations on the assumption that the chloride concentrations of the two specimens were equal would lead to erroneous values for the volume of mucus added by the stomach (e.g. for Dog 4 in the experiment illustrated in Fig. 1, 86 cc.).

The results of such calculations are, however, of value in other respects. Teorell (*11*) views the gastric mucosa as a dialyzing membrane which is permeable to sodium chloride among other substances. These data offer impressive evidence that the chloride added by the stomach to the alkyl sulfate solutions is only partly the result of an actual secretion of chloride with the mucus, being derived to a greater extent from tissue fluid (blood) by diffusion. Furthermore, since the chloride addition is accompanied by an actual decrease in the volume of solution introduced into the stomach, a corresponding and quite considerable amount of water must have been absorbed. These results are of especial interest, since the problems of the absorption by, and diffusion through, the gastric mucosa are still moot questions in gastric physiology.

The effect of the alkyl sulfates on gastric secretion is not limited to the period of contact with the mucosa. After the withdrawal of the agent the secretion of mucus continues at a very high, although gradually diminishing, rate for several hours.

Fig. 1 shows data of the rate of secretion of mucus and the output of mucin for a representative experiment. Our other experiments gave strikingly similar results. According to Babkin and his associates (*1*), rhythmic stimulation of the vagi with a weak current is a rather specific stimulus for the secretion of mucus. Babkin selected one of Vine-

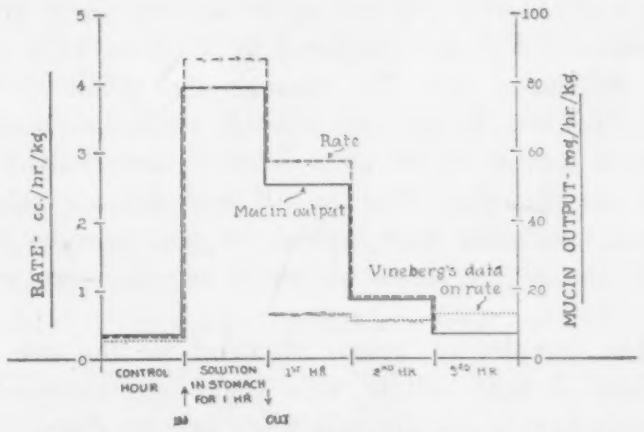

FIG. 1. Mucous secretion of Dog 4 (female; weight, 7 kg.; nembutal anesthesia; esophagus and pylorus tied; gastric fistula; stomach filled with 2-per cent aqueous sodium dodecyl sulfate for 1 hour).

berg's experiments (*12*) as representative of such an effect in the dog. When we calculated from Vineberg's table the volume of secretion per hour per kilogram body weight (results incorporated in Fig. 1), on which basis we calculated our own data, the

[2] To be reported.

mucigogue effect of the agents we employed was found to be much greater than that of such a powerful stimulant as rhythmic stimulation of the vagi.

The mechanism for the stimulation of mucus secretion by the alkyl sulfates appears to be mainly, if not exclusively, a local one. The introduction of a 2-per cent solution of the alkyl sulfates into an isolated pyloric pouch in a dog under anesthesia was without effect upon the secretion of mucus from the body of the stomach. Furthermore, mucus secretion stimulated by these agents was not appreciably influenced by atropinization of the animal.

hyperemia after the use of sodium dodecyl sulfate. However, after the use of sodium "Lorol" sulfate the gastric mucosa displayed areas the condition of which no longer could be considered as a response within the limits of physiological stimulation. Comparing our results with those recently reported by Hollander (*3*) for a variety of mucus stimulants, sodium dodecyl sulfate appears at this stage of the investigation to be the most innocuous stimulant of gastric mucus secretion.

Evidence is accumulating to show that a constantly renewed layer of mucus is the chief agent which protects the mucous membrane of the stomach from digestion by such a highly destructive agent as active gastric juice. Any breakdown of this mechanism will contribute to the development of ulceration. An agent specifically stimulating mucus secretion should, therefore, enhance such a protective mechanism. If we consider that in addition to their mucigogue property the alkyl sulfates also have the ability to inactivate pepsin under certain conditions, these agents appear to have promise for the treatment of "peptic" ulcers, provided conditions of administration can be devised to permit effective action of the drug.

TABLE 1

COMPOSITION OF GASTRIC SECRETION IN RESPONSE TO 2-PER CENT AQUEOUS SODIUM ALKYL SULFATE

Alkyl sulfate	No. of samples	Chloride m.eq./liter		No. of samples	pH		No. of samples	Alkalinity m.eq./liter	
		Range	Mean		Range	Method		Range	Mean
Sodium dodecyl sulfate	16	95–134	118	20	7.5 –8.7	Color.	9	23–37	29
				5	8.27–8.42	Electro.			
Sodium "Lorol" sulfate	6	95–127	115	7	7.1 –8.6	Color.	5	27–31	30

The mucus secreted under the influence of the alkyl sulfates has physical and chemical properties very similar to those described in the literature as most representative of pure gastric mucus. This mucus appears as one of two types: one, opaque and so viscous that, in handling, it could only be divided by cutting with scissors; the other, clear, gelatinous and quite viscous, but still fluid enough to flow, though with great difficulty, through a small glass cannula.

The analytical data (Table 1) for chloride, alkalinity, and pH values of the mucus secreted are in good agreement with those reported by Vineberg (*12*) and by Hollander (*3*). We consider the action of the alkyl sulfates, in the concentration studied, upon the gastric mucosa to be quite selective and limited to the mucous cells, since the pH and chloride values of all specimens were typical for pure mucous and only the merest traces of peptic activity were seen in a few.

The samples of mucus obtained by the use of sodium dodecyl sulfate were found on microscopic examination to contain only a few cellular elements—single leucocytes and columnar cells in various stages of disintegration. These are considered normal constituents of mucus. Careful gross examination of the gastric mucosa immediately after the completion of the experiment showed only an active physiological

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Degradation of Streptomycin and the Structure of Streptidine and Streptamine

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Brink, *et al.* (*1*) recently described the degradation of streptomycin into two basic fractions which they designated as streptidine and streptobiosamine. Information concerning the composition of streptobiosamine and its derivatives was presented, and the empirical formula of streptidine was given. Similar work has been in progress in our laboratories, the results of which closely parallel those reported. The purpose of this communication is to present certain of these data with especial reference to the structure of the streptidine.

Streptomycin hydrochloride (*2*) is completely inactivated on standing 24 hours in anhydrous 1.0 N methanolic hydrogen chloride without forming a new basic group. The addition of two volumes of ether completely precipitates the guanidine, which we previously reported (*2*) as one of the functional groups of streptomycin. From the supernatant solution there is readily obtained an amorphous, optically active hydrochloride of a nonguanidine base whose properties agree with those of "methyl streptobiosaminide dimethyl acetal hydrochloride" (*1*).

Addition of picric or sulfuric acid to an aqueous solution of the guanidine hydrochloride gives an insoluble crystalline picrate or sulfate. These salts are readily recrystallized from hot water.

Guanidine picrate: m.p. 271–273°. *Anal.* Calcd. for $C_8H_{18}N_6O_4 \cdot 2C_6H_3N_3O_7$: C, 33.34; H, 3.36; N, 23.33. Found: C, 33.33; H, 3.60; N, 23.50.

Guanidine sulfate: Dec. ca. 310°. *Anal.* Calcd. for $C_8H_{18}N_6O_4 \cdot H_2SO_4 \cdot H_2O$: C, 25.40; H, 5.82; N, 22.20; S, 8.45. Found: C, 25.43, 25.75; H, 5.63, 5.86; N, 22.20 (Micro Dumas), 0.0 (Van Slyke amino nitrogen); S, 8.57, 8.30.

Guanidine hydrochloride: Obtained by dissolving the picrate in methanolic hydrogen chloride and adding ether. *Anal.* Calcd. for $C_8H_{18}N_6O_4 \cdot 2HCl$: C, 28.66; H, 5.97; N, 25.08; Cl, 21.19. Found: C, 29.10; H, 6.23; N, 24.20; Cl, 20.80.

These analytical data agree best for salts of a diguanidine base of the composition $C_8H_{18}N_6O_4$. This compound has the same empirical formula as that suggested by Brink, *et al.* (*1*) for streptidine, and, although there are no confirmatory data, we presume they are identical.

Streptidine sulfate is also obtained in excellent yield by allowing a solution of streptomycin chloride in 1 N sulfuric acid to stand at 37° for 45 hours. The sulfate is precipitated in nicely crystalline form by adding three to five volumes of acetone to the reaction mixture.

Streptidine is hydrolyzed by refluxing for 48 hours with 6 N alkali yielding four moles of ammonia and a new base, for which we propose the name streptamine. This base is readily isolated as the slightly soluble sulfate by neutralizing the hydrolysis mixture with sulfuric acid and adding an equal volume of methanol. The sulfate thus obtained is purified by recrystallization from aqueous methanol.

Streptamine sulfate: Dec. ca. 340°. *Anal.* Calcd. for $C_6H_{14}N_2O_4 \cdot H_2SO_4$: C, 26.10; H, 5.83; N, 10.13; S, 11.60. Found: C, 26.67; H, 6.10; N, 9.91 (Micro Dumas), 10.03 (Van Slyke amino nitrogen); S, 11.55.

The hydrolysis of streptidine evidently proceeds as shown in the following equation:

$$\underset{\text{Streptidine}}{C_8H_{18}N_6O_4} + 4H_2O \rightarrow \underset{\text{Streptamine}}{C_6H_{14}N_2O_4} + 4NH_3 + 2CO_2$$

These results, coupled with titration data and the Sakaguchi test, establish with some certainty that the six nitrogen atoms of streptidine are present as two monosubstituted guanidine groups which are replaced by two primary amino groups in streptamine.

Streptamine is converted into a mixture of polybenzoyl derivatives by the Schotten-Baumann procedure. Further treatment with benzoyl chloride in pyridine yields a product melting at 350–351°, the analyses of which agree fairly well for hexabenzoylstreptamine.

Anal. Calcd. for $C_{48}H_{38}N_2O_{10}$: C, 71.79; H, 4.77; N, 3.49. Found: C, 71.02; H, 4.94; N, 3.55.

Hexabenzoylstreptamine is converted into N,N-dibenzoylstreptamine by refluxing with 0.5 N methanolic sodium hydroxide. The N,N-dibenzoyl derivative melts at 276–277° and gives a negative ester test.

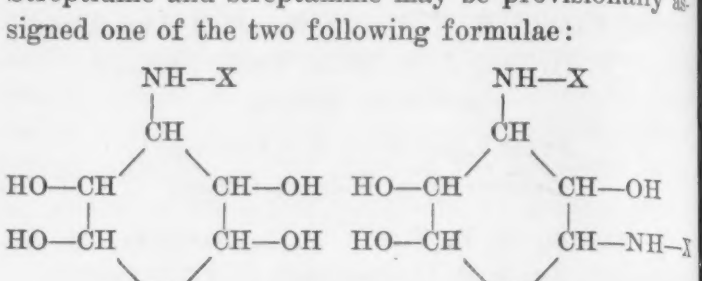
Anal. Calcd. for $C_{30}H_{22}N_2O_6$: C, 62.14; H, 5.75; N, 7.25. Found: C, 60.05, 60.64; H, 5.78, 6.05; N, 6.93, 7.20 (Micro Dumas), 0.0 (Van Slyke amino nitrogen).

Hexa-acetylstreptamine is produced by heating streptamine sulfate with sodium acetate and acetic anhydride, the crude product being purified by sublimation under reduced pressure. Hexa-acetylstreptamine is relatively insoluble in organic solvents and sublimes below 350° when heated on a hot stage.

Anal. Calcd. for $C_{18}H_{26}N_2O_{10}$: C, 50.23; H, 6.09; N, 6.51. Found: C, 50.18; H, 6.20; N, 6.66.

Periodate oxidation of streptidine, streptamine, and their derivatives: Since these substances are polyhydroxy compounds, a study of their behavior toward periodate seemed promising. As a model compound guanidoethanol sulfate was investigated. In contrast to ethanolamine, the guanidine derivative did not reduce periodate at pH 2–7. Streptidine reduced two moles of periodate; streptamine, six; dibenzoylstreptamine, two. No formaldehyde was formed from any of these compounds.

The fact that streptamine requires six moles of periodate indicates that the four hydroxyl and two amino groups are located on adjacent carbon atoms. The absence of formaldehyde production and the utilization of six moles of periodate both strongly point to a cyclic structure, since an open chain molecule should yield at least two moles of formaldehyde and require only five moles of periodate. On the basis of these results and the analytical data, streptamine is best formulated as a diaminotetrahydroxycyclohexane. Of the three possible arrangements of the amino groups (1,2; 1,3; 1,4) the 1,2-isomer is excluded by virtue of the fact that streptidine and N,N-dibenzoylstreptamine consume only two moles of periodate, whereas the 1,2-compound would use three moles. Streptidine and streptamine may be provisionally assigned one of the two following formulae:



Streptamine X = H

Streptidine X = $-C(=NH)-NH_2$

The isolation of the products resulting from the periodate oxidations is in progress and should distinguish between these possibilities.

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Scanning Science—

Helmholtz, Hertz, and Kundt, the three greatest physicists of modern Germany, have died within two years, and the friends of German science feared that this loss would be followed by a standstill in physics, or at least by a lack of really important discoveries. But now we have Professor W. Röntgen's investigations in the physical laboratory of the University in Würzburg, the importance of which does not stand behind the famous electrical discoveries of Hertz in Bonn. Röntgen has found a new kind of rays—he calls them the X-rays—which though invisible to the eye, affect the photographic plate; which produce fluorescent phenomena; which pass through wood, metal and the human body; which are neither broken by prism and lenses nor reflected.

The chief facts about the X-rays are the following: It is well known that the discharges of a large Ruhmkorff induction coil produce in a vacuum tube, such as Crookes' or Hittorf's, colored rays which go in straight lines from the cathode to the glass of the tube. These cathode rays, which have been much studied, are visible to the eye and are well characterized by the fact that the magnet changes their direction; they do not pass thick cardboard, wood, etc. The place where these cathode rays reach the glass of the tube is the centre of Röntgen's X-rays. They are not visible and are not turned aside by a magnet; in short, they are not cathode rays, but are produced by them. Prisms and lenses do not diffract the rays, nor do prisms of hard rubber or aluminum. Lenses do not refract the rays and therefore ordinary photography is not possible; the pictures of the objects are only shadows. But these shadow-pictures can be taken in the closed window box of the camera in a light room, as the sunlight of course does not pass through the wood while the X-rays do. In this way Röntgen took photographs of a set of metal weights in a wooden box and of a thick wire wound as a spiral around a wooden stick; the wood was pervious, the metal of that thickness not, and so the shadows of the weights and of the wire are seen in the photograph, those of the wood scarcely at all. In the same manner he took the picture of a compass needle in the closed box. The door between two rooms did not hinder the chemical effect.

With regard to the nature of the X-rays it seems too early to say anything definite. Röntgen emphasizes the fact that they show no refraction and probably therefore move in all substances with equal velocity and are transmitted by a medium which exists everywhere and in which are the molecules of the substances.

—31 January 1896

In the Laboratory

A Photographic Method for Recording Ureteral Kinetics in Situ

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A device for recording ureteral kinetics in situ has been described by Trattner (*3*). During a series of experiments on dogs using a similar apparatus, several undesirable features became apparent. A membrane tambour yields a tracing which is approximately a logarithmic function of the pressure applied; therefore, the sensitivity is reduced appreciably when working with increasing pressures. The elasticity of a membrane exerts a similar effect on fluid displacements so that successive increments or decrements of liquid are not recorded isometrically. The fling of a lever arm further adds to the inaccuracy of the method. Friction of the writing style on a smoked drum became perceptible when working with small animals. The purpose of this paper is to describe a recording unit to replace the membrane tambour with its lever and writing style.

Fig. 1 shows schematically the construction of such a unit, which consists of a small test tube to which two soft-glass tubes of about a 2-mm. bore are affixed.

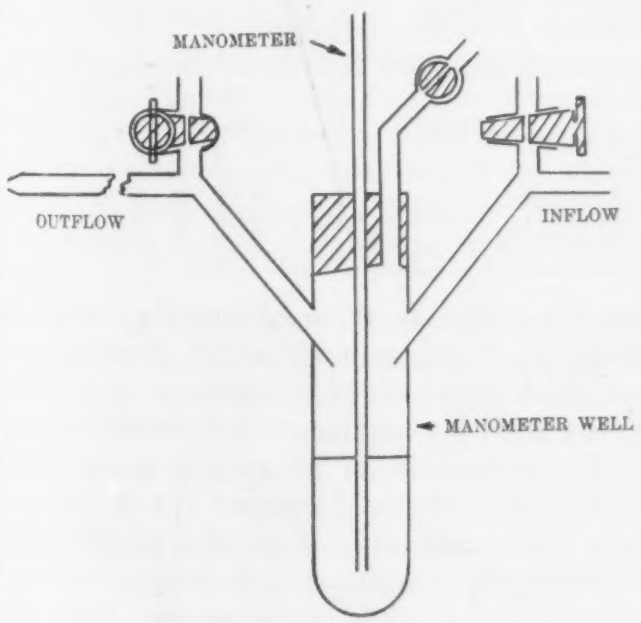

Fig. 1.

These serve as inflow and outflow conduits, respectively. As in Trattner's apparatus, the outflow orifice is constricted so that the ureter is working against a resistance which can be altered at will by using different-sized hypodermic needles, or an aperture of constant bore connected by a rubber tube a few centimeters long so that it can be raised or lowered. Valves are placed at strategic points to facilitate expulsion of air bubbles so that an all-liquid system can be realized. The principle of this unit is based on Pascal's Law, which states that pressure exerted at any point upon a confined liquid is transmitted undiminished in all directions. A rubber stopper in the open end of the test tube supports a 1-mm., even-bore, soft-glass tube of convenient length which serves as a manometer. Such a small-caliber manometer allows measurement of 1 cmm. or less of liquid displacement. The stopper is designed with a depression in the bottom so that a valve for releasing air bubbles from the manometer well (test-tube section) can be incorporated in the unit. The manometer well contains bromobenzene (phenyl bromide), this compound being chosen because it has a density of 1.4991 (*1*) and a surface tension of about one-third that of water; furthermore, it is immiscible with water (0.0446 grams are soluble in 100 cc. of water at room temperature).

An excellent method for recording the excursions of a liquid in a manometer photographically has been reported by Kirchhof and David (*2*). However, a method which has been found suitable is to saturate bromobenzene with methyl red. This solution is photographically opaque to bromide paper and will cast a shadow when the manometer is juxtaposed to a thin slit in a light-tight box and adequate illumination is provided. For this purpose a 500-watt, clear glass tungsten bulb is satisfactory. To obtain a continuous tracing the bromide paper is fastened to a kymograph drum within the box with scotch tape. A record secured in this fashion is shown in Fig. 2.

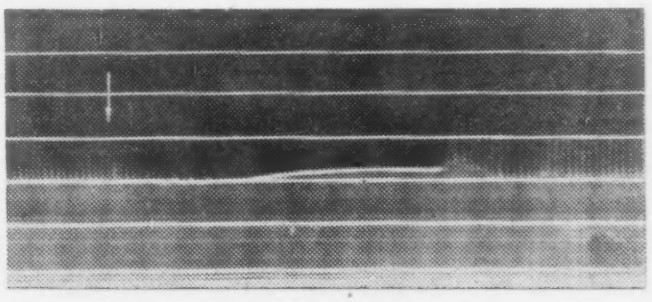

Fig. 2.

Prior to recording, the optical system is aligned and adjusted by trial and error. The distance between the light source and the manometer, as well as the distance between the manometer and the paper, must be regulated to achieve sharp contrast. The unit is filled with physiological saline solution. Hydrostatic pressure from the liquid in the inflow and outflow arms forces bromobenzene into the manometer, the meniscus of

which establishes a base or zero pressure line. A catheter from the ureter filled with either physiological saline solution or urine is connected to the apparatus; any bubbles which appear during this maneuver can be evacuated by means of the valve on the inflow conduit.

A more complete study of the ureter is possible when an automatic drop recorder is appended to the unit.

It has been found that intravenous infusion of a 5- or 10-per cent dextrose solution during the course of an experiment insures a motile ureter, whereas hypodermic administration does not always promote a diuresis adequate to stimulate the ureter.

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The Estimation of Streptomycin in Body Fluids

CLIFFORD W. PRICE, JEAN K. NIELSEN, and HENRY WELCH

Food and Drug Administration, Washington, D. C.

Increasing interest in streptomycin as a chemotherapeutic agent has made apparent the need for a simple method for estimating the concentration of this drug in body fluids.

Stebbins and Robinson (*3*) proposed an agar cup-plate method of assay employing *Staphylococcus aureus* SM as the test organism. This method, which measures concentrations of from 1 to 20 micrograms/ml., requires materials and techniques which may not be readily available in a small laboratory.

A 3-hour turbidimetric assay, which had been giving accurate and reproducible results when aqueous or buffered solutions of streptomycin salts were assayed, was investigated. This method, which employs a non-encapsulated strain of *Klebsiella pneumonia,* was found to be unsatisfactory because of the stimulating effect exerted by body fluids on the test organism.

A survey of our stock cultures demonstrated that several were sensitive to streptomycin when examined by the serial dilution method, employing a modified medium consisting of peptone 1 per cent, beef extract 0.5 per cent, and sodium chloride 0.25 per cent adjusted to pH 7.8–8.0 with NaOH. Further investigations revealed that one of these, *Bacillus circulans,* was the most sensitive and gave accurate, reproducible results with various body fluids. Consequently, it was chosen as the test organism.

B. circulans is a mesophilic, motile, aerobic spore-bearing microorganism. It grows well at temperatures between 30° and 37° C., forming floccules which make the end point in the serial dilution test relatively easy to determine. It is sensitive to 0.15 microgram/ml. of streptomycin base. Broth cultures are quite stable and may be preserved in screw-cap bottles under refrigeration for periods of one month with no appreciable loss in sensitivity.

Technique of the test: Amounts (0.5 ml.) of the modified nutrient broth are placed in sterile Wassermann tubes and serial dilutions by halves made by adding 0.5 ml. of the fluid being tested to one of the tubes and carrying 0.5 ml. by serial dilution for the desired number of tubes. The first tube in the series contains 0.5 ml. of the solution under test only. A standard is prepared for comparison by diluting a streptomycin salt of known potency in broth to contain 10 micrograms of the base per milliliter. This standard is serially diluted in the same manner as the body fluid under test. One and one-half milliliter of a 1:100 dilution of the test organism in broth is then added to all tubes, after which they are incubated overnight. The last tube in which no growth occurs is considered the end point.

The concentration of streptomycin in the unknown is then determined by comparing the end point with that of the standard. An example is given in Table 1, in which it will be noted that the standard completely inhibited growth of *B. circulans* in the fifth tube.

TABLE 1

Fluid	Tube No's.						
	1	2	3	4	5	6	7
Standard	0	0	0	0	0	+	+
Serum	0	0	0	+	+	+	+
Urine 1:50	0	0	0	0	+	+	+

Since this represents 10 micrograms, the serum tested contains one-fourth as much, or 2.5 micrograms; the urine which caused complete inhibition in the fourth tube contained 5 micrograms × 50 or 250 micrograms/ml. To determine lower potencies it is necessary to vary the dilution series of standard and unknown.

In a similar method (*2*), employing *Bacillus subtilis* for determining penicillin in body fluids, it was found that unexplained inhibitory substances often interfered, necessitating a control series for proper evaluation (*1*). To determine whether similar inhibitory factors were present against *B. circulans,* the sera from approximately a hundred individuals were tested. Only one of this number possessed inhibitory properties in a serum dilution of 1:4 for *B. circulans.* In a second series, the sera of 40 individuals being treated

with oral penicillin were also examined for inhibitory substances against this organism. Three of these showed inhibition in serum dilutions of 1:4. The greater majority of these persons had received penicillin many times in the past. The possibility that penicillin in some cases may actually induce formation of these inhibitory substances is worthy of consideration. In no instance was the penicillin concentration itself sufficiently high to act as an inhibitor of the test organism. Inasmuch as the effect of these inhibitory substances on the validity of results obtained by this serial dilution method for determining streptomycin is practically negligible, the use of a control series on each serum does not appear necessary.

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Continuous Anesthesia for Insects

Carroll M. Williams

Society of Fellows, Harvard University

Although surgical procedures on insects have already furnished a substantial body of information with regard to developmental physiology and morphogenesis, such studies have in most cases been difficult to perform, due to the lack of an adequate method of maintaining insects anesthetized for prolonged periods of time. Many insects, especially in immature stages, have shown marked resistance to ether, the agent most commonly employed, and, furthermore, its effect is usually so transient that only the briefest procedures are generally possible before the anesthesia must be repeated.

It has long been known that insects are rapidly and reversibly anesthetized by carbon dioxide, but, here again, recovery occurs so quickly that little can be accomplished. What is needed is a method of administering continuously an anesthetic concentration of carbon dioxide.

During the past year such a method has been developed and tested. It has now been used routinely on a sufficiently large array of insect species to demonstrate its general utility, and it has also been used with uniform success at a number of other laboratories. The only requirements are a Buchner funnel of suitable size and a tank of carbon dioxide (Fig. 1). The operations are performed in the open depression of the funnel, through the bottom of which passes a slow stream of gas from the cylinder. Since carbon dioxide is heavier than air, it persists in the mouth of the funnel, making a lid unnecessary. Any depth of anesthesia can be established and maintained by merely adjusting the rate of gas flow.

For minute dissections it has been found most satisfactory to mount the funnel flush in the top of a table and just beneath a dissecting microscope. For microscopes with elevated stages, the funnel can be fitted

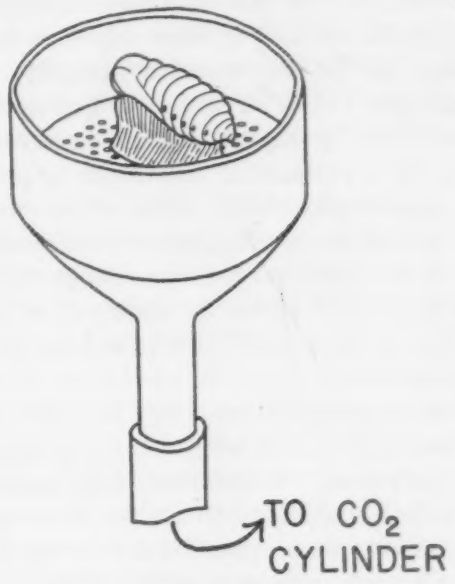

Fig. 1.

to a metal plate and substituted for the glass stage, thus affording a portable unit. In order to indicate the rate of flow of the gas and to prevent evaporation from the insect, it is desirable to bubble the carbon dioxide through water before passing it into the funnel.

The animal to be studied is simply placed in the funnel, where it rapidly becomes anesthetized. The rate with which this occurs varies enormously among different types and stages of insects, being almost instantaneous for most adult and larval forms and considerably longer for pupae. In the latter case it may be necessary to cover the funnel briefly in order to induce anesthesia. For most insects a tension of carbon dioxide amounting to one-fourth of an atmosphere serves to maintain anesthesia, so that a slow flow of gas suffices. When used routinely, a large cylinder of carbon dioxide lasts for several months.

The rate of recovery following removal from the funnel also shows great variation among different insect species, but in my experience complete recovery always occurs, even though the anesthesia may have lasted for considerably more than an hour.

Insects anesthetized by this means show complete relaxation; the integument can be opened, the operation performed, and the body wall sealed shut again without the loss of a drop of blood. The method can be confidently recommended to students of insect physiology.

Letters to the Editor

Pleistocene Fossil Excavations
at Blue Licks Spring, Kentucky

Fearful that the proposed U. S. Flood Control dam near Falmouth might permanently impound water to a considerable depth over the well-known Pleistocene vertebrate fossil site at Lower Blue Licks Spring on the Licking River in the northeastern bluegrass region of Kentucky, Major Victor K. Dodge, a distinguished amateur naturalist of Lexington, recently sponsored at his own expense an experimental excavation to prove that a wealth of unrecovered fossil bones of Glacial animals was still to be had for the digging at this famous locality. The writer was requested by Major Dodge and Mr. William J. Curtis, curator of the adjoining Blue Licks State Park Museum, to be present and to aid in the direction of the exploration.

About two wagonloads of "big bones," principally *Mastodon americanus*, but with some representatives of *Elephas primigenius, Magalonyx jeffersonii, Symbos cavifrons*, and *Bison bison*, if not *latifrons* and/or *antiquus*, had already been taken from this site by Thomas W. Hunter (deceased) from hand-dug trenches surrounding the old saline-sulphur spring during the period 1897–1900. These "big bones" are now in the museum at Blue Licks State Park.

The Dodge exploration was begun with a bulldozer on the morning of 14 October 1945 along a selected strip 8 to 10 feet wide and about 20 feet removed to the southwest from the old salt spring. Three feet of brown silt-loam, sand, clay, gravel, and loose limestone slabs and rubble were removed. This bed of unconsolidated river deposits gave much evidence of having been previously turned over, probably by Mr. Hunter. Beneath it, an additional 1½ feet of alluvial deposit was found to contain scattered brownish fragmental bones of the deer, the elk, and the buffalo. This upper 4 to 4½ feet is of Recent and sub-Recent (post-Glacial) age.

Immediately below the river deposits described above, there appeared in the excavation a black, coarse, firmly-cemented gravel, the pebbles or cobbles of which, when broken, revealed usually chert, occasionally fine sandstone or dense crystalline limestone. These pebbles were set in a matrix of countless small Pottsville quartz pebbles and fine quartz sand, the entire bed ranging from 3½ to 4 feet in thickness. This bed was of a very dark or gray-black to jet-black color, due to thorough impregnation of sulphur and iron, the latter forming the cement of the bed. This semiconsolidated gravel is definitely of fluvial origin and of late Pleistocene age. It rests directly on water-cut and grooved, Cynthiana (upper Ordovician) limestone, bedded and in place. The entire fluvial section, opened down to the bedded limestone at Blue Licks Spring, ranges in thickness from 8 to 9 feet, depending upon the level encountered in the underlying limestone.

When the black gravel was encountered in the excavation, the writer recommended disuse of the bulldozer and began careful removal of the pebbles from the gravel by hand pick. Almost immediately a shoulder blade, vertebrae, and short limb-bones of the Bison were revealed on the southwest side of the cut and were carefully removed. Turning then to a lower exposure of gravel in the northeast side of the trench, discriminating digging soon exposed a very large limb bone which, when completely uncovered and removed, proved to be about half of the humerus of the Mastodon. Later, two fractional vertebrae and about 7 feet of the tusk of the Mastodon were uncovered. Of this tusk some 3 feet crumbled, the balance of nearly 4 feet being removed. During the slow hand-digging necessary to find and lift these frail Pleistocene vertebrate fossils, an inconspicuous fragment of bone was removed which, now that it is cleaned, appears to be about half of the lower mandible of *Castoroides ohioensis*, the giant Glacial beaver, and the first to be recognized at this locality.

All of the "big bones" recovered in this exploration were found to occur exclusively in the hard, basal, black gravel. Several of them, including the Mastodon tusk, give evidence of stream wear or planation; all were separately imbedded in disorder in the gravel when it was a soft and unconsolidated river-deposited bed surrounding the salt spring, prior to the accumulation of any of the overlying brown, silty, sandy loam.

The Pleistocene fossil bones recovered in this exploration were immediately removed by Major Dodge to the University of Kentucky Archaeological Laboratories in Lexington, where they have been cleaned and placed upon exhibition by Professor W. G. Haag.

After the removal of the Mastodon tusk late in the afternoon, the bulldozer was re-employed, the trench then about 8 or 10 feet wide and exposing 15 or 20 feet of the black gravel bone-bed, was quickly refilled and the surface leveled to approximately its original appearance before the end of the day. Approximately 75 people—many of them active amateur naturalists, others scientifically trained in archaeology, including Charles E. Snow, anthropologist of the University of Kentucky—were present from northern central Kentucky, southwestern Ohio, and southeastern Indiana.

This modern, quickly executed fossil hunt has confirmed the previously expressed opinion of Major Dodge, the writer, and others that the Lower Blue Licks Spring is still a locality rich in Pleistocene vertebrate fossils. The success of the undertaking points dramatically to the immediate importance of formulating some systematic, adequately financed plan which will make it possible to prospect thoroughly the two-acre, old bog between the former salt spring and the Licking River channel, and to recover for the use of science the undoubtedly

amount of vertebrate paleontological material still entombed there. Possibly as the result of such promptly and properly executed excavations many bones, if not complete skeletons, of those missing members of the American Pleistocene fauna, *Equus complicatus, Tapirus haysii, Mylodon harlani, Ursus americanus,* and some representatives of the exceedingly rare *Canidae* and *Felidae,* neither of which are now known in Kentucky, may be recovered, with consequent enrichment of our knowledge of the mammalian scene immediately south of the continental ice sheet during the last stages of the Glacial age.

WILLARD ROUSE JILLSON

Frankfort, Kentucky

Why Not?

Settlement of the atomic bomb question is the most urgent of all Government problems. While our statesmen play Pearl Harbor politics in the house of state the conflagration of a Third World War is already smoldering in the basement. The public is fast asleep or unaware of its implications. I suggest that the AAAS take the lead in getting all state academies and science clubs to present the facts in terms of destruction by the atomic bomb to the public, labor organizations, American Legion, etc., furnishing them with a plan of action.

LYELL J. THOMAS

University of Illinois

An Appeal

We the undersigned, wives of American scientists, have read with interest and concern the "News from Abroad" in recent issues of *Science*. We want to help these scientists, victims of the Axis, and we suggest the desirability of supplementing the work of the established relief agencies by sending gift packages of clothing and food directly to individual scientists and their families. Some of us have already sent packages to friends whose present addresses are known, and the acknowledgments we have received leave no doubt of the urgent need which these packages are helping to meet. Used clothing and shoes are genuinely appreciated.

American scientists who would like to send packages to colleagues of the occupied countries may obtain names and present addresses from the Secretary of this group. It is suggested that you indicate the country of your greatest interest and the ages of the children for whom you can supply clothing. We have just received from the Netherlands the names of some forty families with suggestions as to what clothing, etc., would best help them. Warm clothing and shoes seem to constitute their greatest need.

A package sent *now* is worth six sent next spring.

LANGHORNE H. BRICKWEDDE, LOUISE MCD. BROWNE, EMILIE H. CONDON, LOLA S. DEMING, EDITH O. HENDRICKS, MILDRED R. MASI, GRACE H. RUARK, GRACE H. SMITH, *Secretary.*

National Bureau of Standards

Ch'ang Shan, a Chinese Antimalarial Herb

Ch'ang Shan, the roots of *Dichroa febrifuga* Lour., has long been used in China for malaria, but as far as we are aware, no scientific studies had ever been made on its antimalarial action until 1942, when a solid extract of this herb was tried on 13 clinical cases of tertian malaria. A dose of 0.03–0.06 gram of the extract (equivalent to about 7.5–15.0 grams of the crude drug) was administered by mouth twice or three times daily for an average of 5 days. In comparison with the results of 152 quinine-treated cases, Ch'ang Shan appeared to be as prompt as quinine in controlling the fever, but its antiparasitic effect was a bit slower, requiring one more day than quinine in converting positive smears into negative.

Both the antipyretic and antiparasitic effects of Ch'ang Shan were demonstrable in experimental animals. A simple decoction of the crude drug was able to reduce the febrile temperature of rabbits inoculated with *B. coli* vaccine. Chicks infected with *Plasmodium gallinaceum* run a course of malaria which is almost invariably fatal if not treated. Ch'ang Shan (1 gram/kgm.), given by stomach tube twice a day for 1 to 7 days, controlled the infection in all cases, as shown by the conversion of positive smears into negative and the prolongation of the survival periods. Such treatment did not, however, prevent relapses, which usually occurred sooner or later. In doses of only about one-fifth that of Ch'ang Shan, the leaves of the same herb (Shuu Chi) were found equally effective.

In the Chinese Book of Herbs (*Pen Ts'ao Kang Mu*), Ch'ang Shan belongs to the category of poisonous herbs. Nausea and vomiting were, however, the only toxic reactions observed in our clinical cases. Acute toxicity tests were made on 5 dogs, 37 ducklings, and 56 chicks, L.D. 50 being 20 grams/kgm. (approximate), 22 grams/kgm., and 14 grams/kgm., respectively. Fatal doses of Ch'ang Shan produced in dogs intense congestion with numerous hemorrhagic patches throughout the whole gastrointestinal tract. Aside from some congestion, no specific lesions were found histologically in the liver, spleen, and kidneys.

With a view to isolating the active principle or principles, our chemical studies were checked at every step by testing on chicken malaria. Up to the present time we have succeeded in isolating from both Ch'ang Shan and Shuu Chi four crystalline substances. Two of these are neutral principles: Dichrin A (m.p. 228–230° C.) and Dichrin B (m.p. 179–181° C.); the other two are alkaloids: Dichroine A (melting at 230° C. with decomposition) and Dichroine B (melting at 237–238° C. with decomposition). In the doses tried, only Dichroine B was found to be effective for chicken malaria, while the other three were all inactive.

C. S. JANG, F. Y. FU, C. Y. WANG, K. C. HUANG, G. LU, and T. C. CHOU

Pharmaceutical Laboratory,
National Institute of Health,
Chungking, China

Book Reviews

How a baby grows: a story in pictures. Arnold Gesell. (With over 800 photographs, arranged and interpreted with the assistance of Katherine Gesell Walden.) New York: Harper, 1945. Pp. 77.

Few scientific careers have been marked by such continuity and concentration of effort as that of Dr. Arnold Gesell. His interest in the young child dates back at least to 1905, when, as a young graduate student, he reported in Professor Burnham's seminar at Clark University on Pestalozzi and Preschool Education. When, a half dozen years later, he completed the manuscript of his first book, *The normal child and primary education,* he was already committed to a lifetime of research on the young child. In order to prepare himself more adequately for his chosen work, he entered upon and completed a medical course at Yale University. Since that time he has authored about twenty volumes, several monographs, and scores of articles on infant and child behavior. Techniques developed in his laboratory at Yale include cinema analysis of behavior patterns and pattern phases, biometric and clinical procedures for the study of maturational differences, the method of co-twin control, and the now-popular screen for one-way visual observation. Among his most important publications are *Mental growth of the pre-school child: an atlas of infant behavior* (two volumes, 3200 action photographs); *The first five years of life: a guide to the study of the pre-school child*; *Twins T and C from infancy to adolescence* (with Thompson); *Developmental diagnosis: clinical methods and practical applications* (with Amatruda); *Infant and child in the culture of today* (with Ilg); and *The embryology of behavior.*

The book here reviewed is a picture story intended to illustrate "the hidden forces of growth which shape the baby's behavior day by day, month by month." There are in all about 800 photographs, selected and arranged to illustrate average trends with respect to (1) control of body and conquest of the physical world, and (2) the development of personality, emotional life, and social adjustments. Topics covered bear the following titles: Infant eyes, Infant hands, Infant feet, Creeping, Babies are not alike, Natural exercise, Sleep, The sense of touch, Play, The bath, Sitting, The baby stands, Infant and family, The patterning of personality, A mirror playmate, Crying, Smiling, Language behavior, A baby's day at twelve weeks, A baby's day at thirty-six weeks, Behavior patterns at one year, Learning and growth, The first three months, The second three months, The third three months, The fourth three months, Early drawing, Block building, The pre-school years, The school beginner, Inborn individuality, Infants are individuals.

Each topic is prefaced by a brief introduction and followed by anywhere from twelve to forty descriptively labeled photographs. The ontogenetic story told in these pictures and the accompanying text is simple enough to be grasped by any intelligent layman, yet interesting to the scientist because the photographs are representative of average growth and behavior. It is, therefore, both a primer and an authentic outline of child development. The author emphasizes, however, that no one baby can be expected to follow the average pattern and that all children are individuals with distinct personalities.

The task of preparing such a booklet was far less simple than might at first appear, for it involved the selection from thousands of photographs just the few hundred that would give the most accurate bird's-eye view of typical behavior development. It is a story that no one else could have told so authoritatively; Gesell alone has such a wealth of photographic materials from which to draw and so rich a background of psychological and pediatric experience for their interpretation.

Here, as in all of Gesell's writings, we see not only the meticulous investigator but one who is also keenly aware of the dramatic aspects of his data—a scientist who has something of the poet in his make-up.

LEWIS M. TERMAN

Stanford University

The Maya of East Central Quintana Roo. Alfonso Villa R. Washington, D. C.: Carnegie Institution of Washington, 1945. Pp. xii + 182. (Publication 559; illustrated.) $2.25.

The Mexican ethnologist, Alfonso Villa R., has in this volume produced a careful monographic study of the so-called X-Cacal tribe of partially acculturated Maya Indians of the chicle forest region of Quintana Roo, of the southeastern part of the peninsula of Yucatán. The community to which most attention was given is Tusik, and the group as a whole is culturally the most isolated of the area. The study was undertaken as part of a general plan of investigation involving four communities ranged on a "gradient" of acculturation or transition from relatively primitive (folk) culture through various stages of change to the culture of the modern city of Mérida, Yucatán. The study as a whole was carried out under the auspices of the Carnegie Institution of Washington and was directed by Dr. Robert Redfield, who has summarized the data and theoretical principles in his book, *The folk culture of Yucatan* (1941). The present monograph deals with the most "primitive" or "least civilized" of the four groups involved.

The author has proceeded with great meticulousness not only to set down the present-day culture of the people but to reconstruct, so far as possible, the aboriginal culture of their Maya ancestors of the region and the historical vicissitudes to which the culture and the area have been subjected. As a straight ethnographic account, therefore, the book rates as a model monograph.

No one should suppose, however, that the "primitive-

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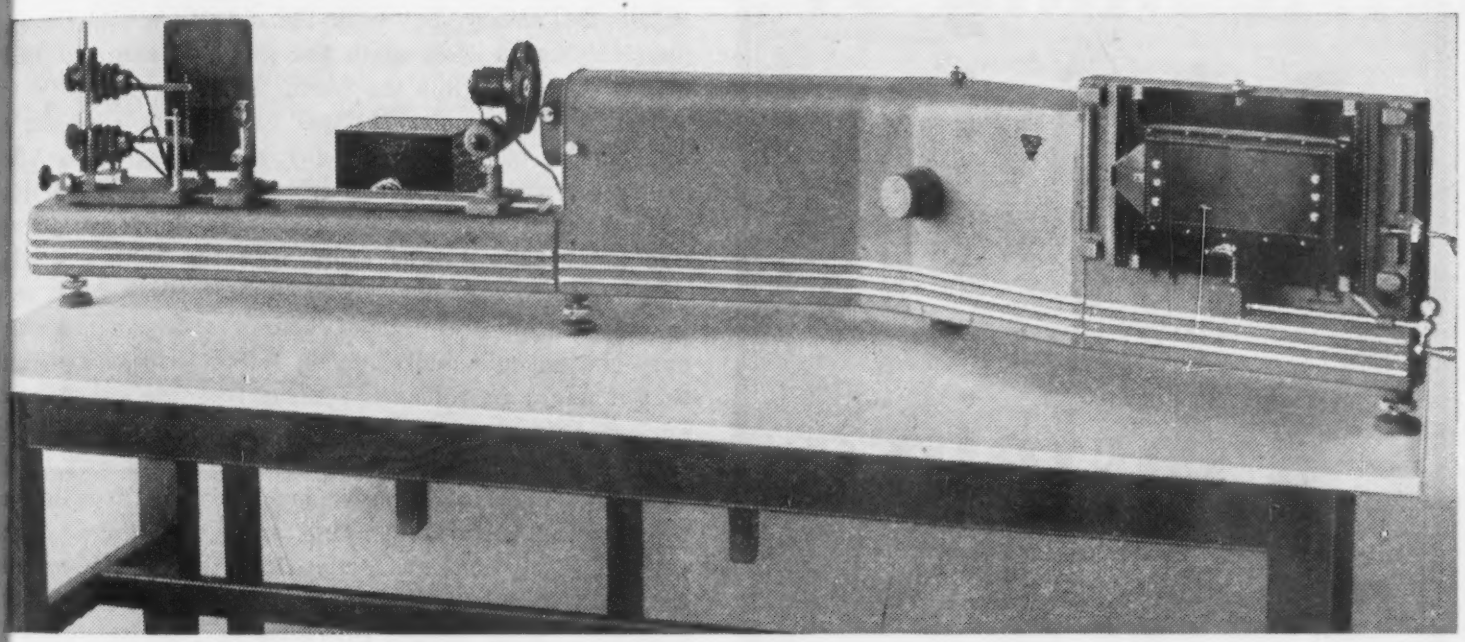

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ness'' of these communities and their culture means ''aboriginal,'' for it is very apparent from the material presented that the X-Cacal have a culture which represents, so far as its content is concerned, a considerable mixture of aboriginal and Spanish elements—a mixing and mingling of artifacts, action customs, and idea patterns which extends through almost every department of custom from subsistence systems to ceremonialism. And in the process of assimilating historically diverse traits to this mixed culture a certain reintegration and synthesis has apparently been at work, with the result that something new has been produced. In this process Maya influence has probably been greatest. An ancient Maya might find slightly more in common with a present-day X-Cacal member than would a Spaniard of the Fifteenth Century, but both the old Maya and the old Spaniard would discover in the modern culture of East Central Quintana Roo ''a world they never knew.''

Thus it is that the X-Cacal group does represent a folk culture of the present day which may be usefully contrasted with the modern urban way of life in Mérida and other Latin-American metropolises, but it is ''primitive'' primarily in the sense that the culture is still relatively homogeneous, still bound together by a universally accepted system of beliefs, still comparatively unspecialized and undiversified, rather than in the sense that it might be considered a survival into our time of ancient Maya culture.

Señor Villa does not attempt an overall summary along these lines nor does he give much explicit attention to processes of cultural blending and emergence as such, perhaps wisely contenting himself with setting down his data in a form which will be extremely useful for other students. Some readers may wish that he had provided at least one chapter of interpretation in terms of theoretical principles, for it is always helpful and stimulating for others to have the theoretical views and tentative conclusions of the man who collected the data. However, we have no reason to complain, for Señor Villa has provided us with a carefully collected and painstakingly documented body of data which should prove valuable not only for our understanding of the cultures of the Yucatecan peninsula, but also for analysis of all mixed or ''Creole'' cultures which, in one form or another, are characteristic of much of modern Latin America.

JOHN GILLIN

Duke University

NSF—*Continued from page 45*

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